# TROPICAL AGRICULTURE

## THE OFFICIAL JOURNAL OF THE IMPERIAL COLLEGE OF TROPICAL AGRICULTURE

VOL. VI No. 9. SEPTEMBER, 1929. PRICE 6d.

**CONTENTS.**


| | PAGE. |
|---|---|
| The Fruit Fly | 241 |
| Colonial Appointments | 242 |
| Virgin Soil Deterioration | 243 |
| Malayan Gutta Percha | 249 |
| Agriculture in North Africa (*Contd.*) | 250 |
| Entomological Notes | 254 |
| Tropical World Notes | 256 |
| Diseases of Cover Crops | 258 |
| Gold Coast Cocoa | 261 |
| Excelsa Coffee | 264 |
| Tsetse Fly Research | 265 |
| Reviews | 266 |
| Books Received | 266 |
| Sugar Notes | 267 |
| Chemical Notes | 268 |
| Sports | 269 |
| College News | 270 |
| College Amalgamated Clubs | 270 |
| Visit of Oxford Explorers | 271 |
| Mycological Conference | 271 |
| Sugar-Cane Megass | 271 |
| Trend of the Markets | 272 |


THE IMPERIAL COLLEGE OF TROPICAL AGRICULTURE, TRINIDAD, B.W.I.

Cables :: "Stomata." | Phone :: 2483.

*TROPICAL AGRICULTURE is published at the Imperial College of Tropical Agriculture St Augustine, Trinidad, West Indies, at the end of the third week of the month preceding the one of issue. Advertisement rates can be obtained at the College from the Editor, or from the Secretary of the College, 14, Trinity Square, London, E.C. 3, England. The Editor will be glad to consider authoritative articles for publication. It is understood that opinions expressed in signed articles are those of the author and do not necessarily represent the policy or opinion of the College Authorities. Increasing numbers of inquiries are being received from various parts of the tropics which can be answered only by persons possessed of an intimate knowledge of local conditions. Enquirers should first satisfy themselves that their local Department of Agriculture is not able to supply them with the desired information before communicating with us. Correspondence which will be replied to is invited on all other matters pertaining to tropical agriculture, science and development.*

## THE FRUIT FLY.

IT is greatly to be deplored that the Mediterranean fruit fly should have recently made its appearance within the borders of the United States of America—an invasion that again brings to the fore the very important questions relating to the introduction of new pests into countries, and to the efficiency of the methods of preventive inspection and quarantine legislation at present in vogue and which concern nearly all the agricultural departments in the world. The rapidity with which the fly has spread from its supposed original home—the Mediterranean countries, the havoc which it has caused on its trail through Bermuda, Hawaii and the Azores, where it has destroyed important fruit industries, the difficulties which it has given to fruit growers in Spain, Italy, South Africa and Australia, all have been sufficient warnings to Americans of the very great dangers fraught with this pest, and of the necessity of keeping it out of their own country. And yet, their very laudable efforts in setting up elaborate and costly machinery to prevent such an invasion have signally failed and it is now feared that if this fly is not exterminated it will spread in the southern states and become a serious menace to the great fruit-growing districts throughout the warmer regions from the Atlantic to the Pacific coast. Such a state of affairs leads us to discuss briefly some views on the fly itself and of the ways and means by which noxious insects can be spread and be prevented from spreading.

The Mediterranean fruit fly which is undoubtedly one of the most dreaded and destructive fruit pests in the world, was first recorded in American regions when it invaded the Bermuda Islands shortly after the middle of the last century, and again about 1910, in the Hawaiian Islands. Fortunately for the West Indies and Central America, it has not yet, to our knowledge found its way there, although it is now distributed throughout the tropical and sub-tropical parts of the world. Its foods include a wide range of fruits and vegetables and the damage is caused by the maggots which hatch and feed within the ripening fruit, thus spoiling it for the market and often rendering it totally unfit for human consumption. When it became known in April last that the fly had been discovered and identified in Florida, the United States Government and the Government of the State of Florida immediately put forward a most energetic campaign. Funds

were provided by the Governor of the State and the President of the Nation, and inspection and clearing up services started in an attempt to eradicate the pest before it should spread beyond the limits of the 80 square miles which were at first found to be infested.

It is from about 1910 that the United States Government has maintained a quarantine inspection service at all ports of entry and frontier points. Fruit flies, the Mediterranean and others, and several species of insects, as well as diseased plant material are intercepted in commercial cargoes, in passengers' luggage, and even in their pockets. Reference to quarantine reports will show that thousands of interceptions are made each year, and whilst many of these are well known pests and diseases, others are insects and fungi which might become of economic importance. Although the American preventive inspection and quarantine service has been remarkably efficient it has not always, unfortunately, proved absolutely infallible. Before it was established, the country had been invaded by the Mexican cotton boll weevil, the San José scale, the Gipsy Moth and other pests of primary importance, but even since the existence of this service, pests which may prove of equal importance have found their way in and amongst these must be mentioned the pink bollworm, the Japanese beetle and the European corn borer. The European corn borer is already invading the great corn belt, the Japanese beetle is thoroughly established in certain eastern localities while in the case of the pink bollworm of cotton, hope is still expressed that the pest may be exterminated.

There are very few countries now which do not harbour some important pest which has been introduced through the ordinary channels of commerce and although routine methods of transmission in cargo or passengers' luggage are well understood, and can be reasonably controlled, it is not so easy to guard against unforeseen methods of ingression. The introduction of insect pests has often been shown to be due either to the carelessness of those who should have been better informed or to complete ignorance as some of the following examples will show. A few years ago at the San Francisco Exhibition samples of cotton from China were shown which were found to be infested with the pink bollworm and indeed proved to be the first record of the occurrence of this insect in that part of the world. In California a law prohibiting the importation of live insects into the State was unintentionally violated by somebody sending a parcel from Kansas containing living grasshoppers which were to be used in trick photography. The collection of souvenirs consisting of twigs and fruits is another way by which pests are scattered and this method is often in evidence in the small West Indian Islands, where tourists take cotton bolls, fruits, pods or leafy twigs in one place only to discard them the next day in a shrivelled condition in another colony. It is not known how the Mediterranean fruit fly entered the United States, but it is probable that something unforeseen gave the insect its chance to establish itself.

The Mexican fruit fly or Orange worm is another pest against which an intensive quarantine inspection has been maintained. This insect, also, got past the quarantine barrier early in 1927 and has caused a short war of extermination on a restricted area in Texas This seems to have been successful for although the insect is commonly to be seen in the market of Matamoros in Mexico, it has not been recorded on the Texan side of the Rio Grande for about two years.

The greatest danger in the distribution of crop pests and diseases undoubtedly lies in the rapid growth of modern transport facilities which bring with them an increasing number of cargoes and passengers—both potential sources of infection. To this must be added the fact that the balance of nature has been considerably disturbed through the opening and planting up of virgin areas which are fresh grounds for the successful development of certain insects. With the help of trade the latter have in turn been exported from their native haunts to new localities, where, no longer under the control of their natural enemies they have done irreparable damage. In fact, the further the problem is studied the more complicated it becomes and the more difficult it will be to find successful means of controlling known pests. The war with insects which began with civilization can never cease and in future only partial control can be hoped for. At present such control consists of the use of poisons, the encouragement of natural enemies, the development of immune or resistant strains of plants and an understanding of the relation of plants in good health to immunity from attacks from certain types of insects. All, although they are not absolute means of control, have their value, but often some trivial and entirely unsuspected circumstances may give an opportunity for invasion, even with the best inspection service. As civilization further progresses the problems to be tackled by entomologists will become more and more intricate but this should not deter the layman from doing his share by studying when he can those pests which may well become a very great danger to the community of which he is a member.

## COLONIAL APPOINTMENTS.

The following appointments have been made by the Secretary of State for the Colonies during the month of June, 1929.

Mr. D. H. Shackles, Assistant Commissioner of Lands, Gold Coast.

Mr. E. D. Stansfeld, Surveyor, Lands Department, Jamaica.

Mr. E. Lawrence, N.D.A., District Agricultural Officer, Nyasaland.

# VIRGIN SOIL DETERIORATION.

## The Deterioration of Virgin Soils in the Caribbean Banana Lands.

By C. W. WARDLAW.

### I.—Introduction.

THE problems of soil deterioration and maintenance of fertility began with the settlement of primitive tribes in localised areas. Migrations of people in early times are frequently attributed to soil depletion, and examples of this are not lacking even at the present day. In countries which have been settled for a considerable time, where population is on the increase, and where the greater part of the good available agricultural land is in use, it is becoming every day more evident that the many problems relating to the maintenance and increase of soil fertility, and consequently productiveness, must receive the most careful attention if food shortage is to be avoided. Thus in Great Britain, Europe, and America the question of soil deterioration has already received considerable attention at the various experimental stations, and information regarding rotation of crops, tillage, and conservation of nutrients, has become common knowledge to the up-to-date practical agriculturist.

In most tropical countries, on the other hand, agricultural science is still, relatively speaking, in its infancy, and as new land in the larger countries is still abundant, problems of soil deterioration have not yet received very much attention. The purpose of this article is to discuss the initial deterioration of virgin tropical soils during the period when bananas are grown continuously as a first crop on an extensive scale, without cultivation.

In older agricultural countries three stages in soil treatment can generally be recognised. In the first, the virgin fertility of the soil is exploited by extensive or crude methods, and the good initial yields quickly decline. The second stage covers the period when the exploited soil undergoes further cropping without any ameliorative treatment. During this period yields are uniformly low. In the third stage, improvement is brought about by scientific treatment; soil condition is improved, the supply of nutrients is increased, and the crop responds by progressively increasing yields. Weitz (1) has shown by statistical records that the latter is true for European and American countries over the past fifty years or more, and that the producing power of the soil has changed appreciably. Howard (2), on the other hand, points out that in India the fertility problem has been a serious one for centuries, and, indeed, that for the last three hundred years the productivity of the soil has not increased appreciably. Little animal manure is available while poverty curtails the use of fertilizers. The tendency, therefore, was for the soil to remain at its minimum standard of production, a standard that is now slowly improving with the application of modern agricultural methods.

In short, in countries where agriculture has been practised for many years, and where the amount of available land is limited, it is now recognised that by suitable rotation of crops, better cultivation, and the proper use of animal and artificial manures, poor and low yielding soils can be greatly improved and rendered more productive.

### II—The Present State of Agriculture in the Caribbean Banana Lands.

In the Caribbean region, *i.e.*, the West Indies, Central America and the northern coast of South America, the forest areas opened up for extensive banana cultivation afford most interesting material for observation on the behaviour of virgin soils when they are passing through the initial stages of single crop exploitation. The cultivation of the banana has been attempted over such a wide range of soils in this region, that a discussion such as this tends to become a consideration of the behaviour of virgin tropical soils in general.

Different species and varieties of bananas are scattered throughout the tropics. Some varieties such as the Canary or Governor banana will grow and yield some fruit under very unfavourable soil conditions. The Gros Michel banana on the other hand is markedly affected by unfavourable cultural conditions, and the stature of the plant, the rapidity with which it bears fruit, and the size of the bunch, give speedy indications of the suitability of the environment. In the same way, leaving disease incidence aside for the moment, soil deterioration after a number of years is quickly reflected in decreased output as measured by the number of standard bunches per acre. As the Gros Michel requires, for its optimum growth, soil with a high amount of natural or acquired fertility, it may be regarded as a good indicator-plant for determining relative soil fertility and condition.

The question of soil deterioration under banana cultivation has been greatly complicated by the ravages of Panama Disease, the wilt disease of the Gros Michel banana caused by *Fusarium cubense*. So great has the virulence of this disease been in Central America and the West Indies that all abandonments of plantations are popularly referred to one cause only—Panama Disease. In a recent report (3) on an extensive tour of the larger banana growing areas of the Caribbean the writer has pointed out that many factors must be considered in the abandonment of banana lands What is true of bananas, is, of course, true, although perhaps to a lesser extent, of many epidemic plant diseases. Among the causes of abandonment of banana land not only must destruction of plants by *Fusarium cubense* and extensive losses resulting from the use of diseased or defective planting material be included, but the accompanying cultural conditions must also be duly considered. An investigation of the latter has shown that several

other important reasons for abandonment can be adduced. In the first place many of the soils chosen under the extensive planting schemes are not in a suitable state of fertility relative to the requirements of the Gros Michel. In their virgin state they are frequently sour, intractable, waterlogged, deficient in humus and insufficiently aerated—conditions to which the Gros Michel is not adaptable. Soil in such initial poor condition invariably gives a poor stand of young plants. Their slow growth allows the rampant weed population to gain ground, so that extra brushing is necessary. In such poor plantations, therefore, upkeep is expensive and fruit production is both slow and inadequate. Soon the economic factor comes into play and the land is abandoned for banana growing. This group of causes of abandonment, then, is referable to the initial choice of land. In some instances the crop takes 24 months to develop instead of 12 to 14 months while in extreme cases the plants never attain normal growth. Such land should, of course, never have been planted with bananas under the existing methods of cultivation.

The most interesting soils are those which have originally, in their virgin state, supported fairly good to excellent stands of bananas and which have subsequently declined in productiveness. The real question of soil deterioration under continuous single crop cultivation is to be sought here. In Central America all stages in soil staying-power were observed from those which had to be abandoned after 4 to 5 years at one end of the scale to others which have supported bananas continuously for 20 or more years and which are still in a first class state of productiveness.

**III.—Causes of Soil deterioration in general.**

Before embarking on a discussion of the causes of deterioration of tropical soils it might be well to summarise briefly what is known about soil deterioration in countries where the results of many long-distance experiments are available. Briefly, it has been demonstrated that the more productive the soil the more rapid will be its deterioration without treatment under continuous cropping, the rate of decrease in production varying, of course, for different crops. While the *individual* application of crop rotation, cultivation, liming, use of manures and fertilizers has not staved off decline in productiveness, the *suitable combination* of some or all of them, according to the requirements of particular soils, has not only maintained production but led to definite increases. Again, while continuous cropping slowly deprives the soil of its several available mineral plant foods, this loss is relatively small. The loss which leads to the greatest and most rapid decline in fertility is the loss of organic matter. In parenthesis it may be observed that the maintenance of humus is one of the greatest soil problems in tropical agriculture.

Within limits, in temperate countries, the amount of suitably incorporated organic matter may be taken as a measure of fertility, and as this supply can be increased by the application of animal manure and the use of cover crops the initial fertility of virgin soils can often be greatly surpassed. Thus Thorne (4) has pointed out that in Ohio many farms are now producing much larger crops than they did when the land was first reclaimed from its original prairie or forest condition. This increased production, which is still continuing, is definitely correlated with the farming methods which have aimed at conservation and increase of the humus supply.

Numerous investigations indicate that virgin lands taken into cultivation lose considerable quantities of nitrogen in the course of 20 years or so, quite apart from that removed in the form of crops. The scientific investigation of this problem is exceedingly complicated. Thus Schreiner (5) observes: "What we lose sight of is that the organic matter of soil is approximately fixed in amount only by the environment: a dynamic equilibrium between its destruction and its supply. However, it is not the equilibrium that is the most important factor in soil fertility, but the dynamics that produce the equilibrium. In a fertile soil this organic matter is in continual change from season to season and on this change depends the very life of the soil and all its fertility-promoting factors, and when organic matter has ceased to change, has become chemically and bacteriologically inert, we have soil infertility. It is the changing organic matter, that makes for soil fertility, not the mere presence or store in the soil." Schreiner's interesting point of view is not necessarily shared by all investigators of soil fertility problems. Thus Waksman (13) points to the importance of the relatively stable substance, humus, derived from organic matter by a series of complicated changes. The colloidal state in which humus is present is regarded by him as important in influencing both the physical and biological activities in the soil. While the changes in soil organic materials are now studied intensively by the methods of detailed analysis in temperate lands the analogous problems of tropical soils still remain almost untouched. It is probable that comparable changes do take place presumably considerably speeded up by the temperature factor.

Other factors involved in the deterioration of soils are the leaching and non-availability of essential nutrient minerals; the presence of substances directly toxic to certain crops; the presence of the wrong kinds of fungal and bacterial organisms; an unbalanced microflora and fauna; waste through soil erosion, and the presence of pests. Many of these factors may be more or less closely inter-related. Lastly, the question of soil deterioration is referable, from certain aspects, to the land policy under which it is issued to farmers and planters. It is not necessary to discuss

# DISEASES OF COVER CROPS.

PLATE I.—*Plant showing dead portion of main stem (light coloured area) branches A and B have been killed by the disease.*

PLATE II.—*Sunn-hemp seedlings attacked by Colletotrichum. Blotches indicate diseased areas.*

## AGRICULTURE IN NORTH AFRICA.

*Jardin d'Essai, Rabat.*

*Winnowing Spelt Wheat at Sidi Okba.*

*Stock Market, Fez.*

this subject in detail here. It will suffice to say that the question is one which comes up for discussion sooner or later in most large countries where new land, originally abundant and cheap, is rapidly diminishing under extensive systems of exploitation. The native fertility of the more accessible land is first exploited, after which settlement is pushed further inland. Ultimately land shortage becomes a factor of ever increasing importance and the soil begins to regain fertility under the skilled agricultural treatment necessitated by these circumstances.

Every soil must be treated on its own merits and according to its environment. Thus the findings regarding the behaviour of temperate soils are not necessarily applicable to the vastly different conditions prevailing in tropical soils. There are, however, certain broad analogies and points of similarity, and it will be shown that some of the aspects of soil deterioration mentioned above are applicable to the deterioration of virgin tropical soils which have been pressed into the service of banana production.

## IV.—The establishment of the modern banana plantation.

At the outset it should be stated that, with the exception of Jamaica, where some excellent examples of cultivation may be seen, the modern extensive banana plantation as a rule receives no detailed cultivation. The method of establishing a banana plantation in Central America is as follows. An area is surveyed and the underbush of the virgin forest is cutlassed sufficiently to allow of the laying out of the rows, the position of each stool being marked by a stake. Suckers or "bits" are then planted in holes 15 inches deep and 15 inches wide. The tall forest trees are then felled, and after some time the young banana plants begin to appear through the mass of trunks, branches and twigs. As both the growth of the plants and the decay of the forest debris take place quickly, in a short time, with periodic cutlassing of the secondary bush, an orderly plantation is established. Apart from a varying amount of attention to drains, the upkeep of pontoon bridges and roads, collecting of fruit, and periodic cutlassing of bush and trimming of stools, the plantations receive no other attention. In other words the native fertility of the soil is utilised with the minimum amount of detailed treatment. When soil deterioration or the incidence of disease reduces the crop to a certain point the plantation is abandoned and new land is opened up.

## V.—Deterioration of Banana Soils.

The most elementary example of tropical soil deterioration is perhaps that which is found on lands occupied by squatters. For example in British Honduras and in the less densely populated West Indian Islands the squatter usually brushes and burns a small area of land, plants a few crops to satisfy his primitive domestic needs, occupies the land for a few years according to its productiveness, then, when soil deterioration results in an insufficient repayment for even his scanty labour, he moves on elsewhere and the process is repeated. The evacuated land is taken possession of by a rampant weed flora and after a number of years the soil regains a measure of fertility and may again be selected for exploitation by a new generation. This may be compared with virgin land cropped continuously with bananas then allowed to revert to bush and subsequently opened again for bananas. In one area in Stan Creek, British Honduras, visited by the writer, a piece of land, cleared for broad scale banana growing by the usual methods, was supporting young banana plants which were growing vigorously and might be expected to give good yields for at least a few years. The soil was of open texture, well supplied with organic matter and would readily part with its store of nutrients. The history of the area was as follows. After being cleared of virgin or secondary forest in 1911 and planted with Gros Michel bananas, good crops were obtained until about 1918, when the land was abandoned because of insufficient production. It was allowed to revert to secondary bush. The abandonment was locally attributed to Panama Disease, but as will be indicated in the course of this article, other factors were also at work. After remaining for a period of 10 years in bush it was again brought into banana cultivation and on inspection in 1928 the favourable condition of the soil for Gros Michel cultivation was borne out by the vigorous stand of young plants. Such land shows two contrasting characters, namely, great fertility in its initial state, and rapid exhaustion under single crop exploitation. The general deterioration is most probably to be attributed to rapid leaching of the open soil under the existing conditions of high rainfall and to rapid depletion of the organic matter content. This instance is quoted to show roughly the time required for the regeneration of a soil of open texture, *i.e.*, one which responds quickly to supplies of organic matter derived from secondary vegetation.

Such open soils are localised and inextensive and are generally found at certain points along the course of small meandering rivers. In contrast to this soil type the great majority of the hillside and alluvial soils of Central America are of a much more compact nature and probably respond more slowly to fallow conditions.

To deal adequately with the deterioration of banana soils it would be necessary to cover a vast amount of ground, and even if space did permit of this the cogent detailed information is not yet available. Of necessity, then, one is confined to generalisations. The soils which have been used for banana cultivation may, from the point of view of fertility relative to the Gros Michel, be divided into three classes:

(1) Poor soils on which the production of the Gros Michel banana very obviously falls off after 4 to 7 years.

(2) Intermediate soils, probably with some initial defect such as compactness, sourness, high water table, or insufficient aeration, whose deterioration after 10 to 14 years leads to abandonment.

(3) Very good soils which have been cropped continuously for 20 or more years and which are still in a first rate state of productiveness.

(1) *Poor Soils.*—Many examples of the first group can be seen in the several countries of Central America. Perhaps the most striking example is to be found in the Canal Zone, Panama. There the banana growing areas are situated around Gatun Lake and along the upper reaches of the Chagres River. These plantations are small and localised and for the most part are only accessible by canoe or motor launch. Most of the fruit is rather small and of indifferent quality, but for want of better is actively competed for by different companies, an important factor being the possession of a fleet of suitable launches and barges.

At the present time banana growing round the shores of Gatun Lake presents some rather unusual features. On account of the impounding of the Chagres River in Gatun Lake to furnish water for operating the locks of the Panama Canal, cultivation is now of necessity limited to the high grounds and hilltops which rise above the new water level. Most of the plantations occur on the typical red and yellow clay soils common to many of the low hills of Central America. For banana-growing this soil is distinctly poor. Consequently, the plantations are short-lived, and after producing for four to seven years they are allowed to go back into bush. Panama disease is of frequent occurrence and is scattered through all the plantations.

The average farm, of about 20 acres, is rented cheaply by a peasant proprietor. Plantations occur here and there on islands (hilltops), valley tops, and hill sides. Most of the available land round the Lake is taken up with small plantations of this type. The general upkeep of the plantations is bad, little brushing is done, and as a rule areas are abandoned after two, three or four crops—in fact, it is a typical example of shifting peasant cultivation. Near the occasional lime out-crops the soil is better so that some of the farms may last for seven years. In this region then we have many typical examples where land has been abandoned, not only on account of disease, but because of the rapid deterioration of indifferent soil in the absence of good husbandry.

What is true of the Canal Zone is true also of Panama, Costa Rica, Guatemala and British Honduras, where bananas have been planted on the rather intractable hillside soils. In all cases an extremely limited production is the rule, and at the present time when explorations for new planting lands are being conducted by the larger companies, such soils are eliminated from the planting programme. These soils, generally associated with hillside spurs, are light red or yellow in colour, are poorly supplied with organic matter, and are so compact as to make rooting of the Gros Michel difficult. Their main defects are compactness and lack of adequate aeration, and careful tillage would be necessary to stave off the inevitable speedy soil deterioration. In regions of high rainfall such deterioration, assuming that this description is correct, is largely associated with soil packing and erosion under the prevailing conditions of high precipitation. Comparable observations were made by the writer ([5]) and E. A. Walters ([6]) on the steep exposed slopes of the St. Lucia banana lands.

(2) *Intermediate soils*—A large number of the banana soils of Central America may be regarded as falling into the second category. As a rule abandonment of the banana lands of Costa Rica and Panama is regarded by the man in the street as being entirely due to Panama Disease. This, however, is a point of view that can only be upheld by completely overlooking the whole question of soil condition, both in its initial and later phases. In Colombia, for example, large areas have also been abandoned but the occurrence of Panama Disease there has not yet been reported.

The soils of this second category are mostly the result of river action, and consist mainly of silty loams, frequently with a considerable amount of clay. As a rule in the Changuinola and Sixaola districts in Panama, in Costa Rica, and in Guatemala, such soils were cropped from 10 to 14 years, more or less, after which they were abandoned. When it is stated that they were abandoned it must not be inferred that the land would no longer support a stand of plants. Many of the abandoned lands observed were still showing an abundance of stools. When a plantation is on the decline, instead of a strong even growth, a much slower, less even growth, with gaps here and there, is the rule. The cost of brushing therefore goes up as productiveness goes down, and, with the larger companies at least, when a certain low yield of fruit per acre is reached, the land is abandoned, although the plantation may still be yielding quite a considerable number of bunches per acre. Abandonment, therefore, is a measure, not of complete infertility, but rather of a certain non-remunerative standard of productiveness, *i.e.*, one which does not adequately meet overhead charges and provide a certain minimum margin of profit.

The question that must inevitably arise in the mind of the agriculturist is: To what must this decline in fertility be attributed? In the present state of knowledge any answer must be

speculative. The cardinal factors, however, may be discussed at this point. These are (*a*) the lime status of the soil, (*b*) aeration and (*c*) supply of organic materials. It may be stated at the outset that most of the soils are sufficiently well provided with most of the essential nutrients but are deficient in lime(7). In view of the physical character of these soils in their untilled virgin state this is most important, and, as in other soils, there is little doubt that the adequate incorporation of lime into the soil would set in motion many ameliorative processes. The need for aeration can be demonstrated, even close to the soil surface, by the most casual observer. Not only have these alluvial soils been compactly deposited under water, but they have also been packed by heavy rain showers. As a result we find, just below the few inches affected by the surface mould, that the soil is compact and highly mottled. This is true even of some most excellent alluvial deposits. The roots of the Gros Michel penetrating into such compact poorly aerated soil fare badly, and are seldom found in their normal white turgid state. Root systems in such soils tend to be horizontal rather than vertical. Nor is the plant, set out originally in a small 15-inch hole given any initial advantage. On the whole soil aeration is better in the first years after planting than it is, say, after ten years. The reason lies in the fact that during the first years stumps of felled trees and their roots, which traverse long distances, rot quickly in the soil. The cavities left by the decayed roots not only greatly increase soil ventilation directly but also indirectly by acting as under-drains. After some years, however, these channels become closed and the soil is slowly compacted to a less aerated state. Another point is that the open drains, well prepared at the beginning, gradually fill in and cease to function. The relation of such conditions to root formation is readily demonstrated by digging a soil section right through a stool. Invariably the depth of rooting is curtailed by the presence of a compact mottled layer close to the surface. But even in spite of this compactness and its concomitant state of poor aeration some alluvial soils support a wonderful growth of Gros Michel bananas. One is led to speculate on the enormous fertility of such soils if they received even a small amount of tillage.

The third factor, supply of organic matter, is perhaps the most important of all in imparting to the soil a long continued fertility. Here again the banana is greatly favoured during the first few years of the life of the plantation. At the time of planting the soil is provided not only with the accumulated mould of the forest floor, but also with large supplies of organic matter resulting from the speedy decay of leaves, branches and trunks of the felled trees. Under the influence of high humidity and numerous fungi, decay is rapid and a rich layer of disintegrated vegetation is spread over the plantation. Furthermore the decay of stumps and thick roots in the soil provides pockets which will become rich in humus and constitute local zones of high fertility. Over the course of a number of years, however, the humus supply disappears, and is accompanied by that decrease in productiveness which is generally a mark of soil deterioration.

The writer took the opportunity in various parts of Central America of examining soil profiles in different virgin forest lands. Many differences in organic matter content were observed, according to the nature of the forest flora. All conditions were found from forest floors with a good depth of surface mould, and underlying soil dark with humus, to floors with practically no accumulated mould and only one or two inches of top soil darkened with humus. For example in an area of giant forest trees in Panama, the forest floor, in deep shade, was practically free of ground vegetation so that one could walk between the tree trunks quite unimpeded. A soil profile showed one to two inches of surface soil of dark colour, due to weathering and incorporated organic matter, with a quick transition to the yellow silty clay below. The debris of felled trees no doubt adds a considerable amount of organic matter but it is an open question whether, in the physical and chemical state of these compact clay-like soils, such additions will be adequately incorporated or will impart a long continued fertility. As a contributor (8) to *Tropical Agriculture* has recently pointed out: "Forests will often thrive on soils which, judged from an agricultural standpoint, have a very low standard of efficiency particularly from the physical and chemical standpoints. Such soils are fertile relative to the trees, but, to bring such areas under agricultural cultivation is a very expensive business, practically involving making new soils. Given a sufficient pressure of population and a concomitant 'land hunger,' it can be done. Otherwise without such pressure, and with cheap land, it only too often means felling and burning then gaining a few years' crops on the residue of the burn, after which the area more or less rapidly becomes covered with a retrograde form of bush." The rapid deterioration of such soils under extensive agricultural treatment is agreed on by most people who have been over the ground. In this second category of soils the writer has placed those in which some initial fertility defect can be observed.

3. *Good Soils.* In the third class of banana soils, namely those which have yielded for 20 or more years and which continue to yield, the soils are in a first class physical and biological condition from the outset—a condition which appears to be maintained. Such soils have been observed by the writer in Costa Rica, Guatemala, and Colombia. Fawcett (9) has remarked that in the early days of the industry in Jamaica "banana land" was accepted to mean a soil in which, without

drainage or tillage, and by the usual superficial processes of clearing before planting, a good yield of commercial fruit was obtained "by the grace of Nature alone." In other words Fawcett was referring to land well situated topographically and in a very high state of general fertility. Extensive areas of such land do exist but they are by no means the rule. On one farm in Costa Rica the writer saw an excellent example. The plantation as a whole presented a strong uniform growth, so that the canopy of banana leaves kept down the weed vegetation to such an extent that brushing was practically unnecessary. Production had continued uniformly for 20 years and was still unabated. When a soil profile was dug through the centre of a stool the major portion of the root system was found to penetrate vertically downwards (in contrast to the horizontal root systems typical of more compact soils) and the roots, abundantly provided with rootlets, were white and turgid and free from disease. Examination of the soil showed it to be a free, well-drained, moisture holding, dark sandy loam. In other words in its natural state it was an ideal Gros Michel soil. The presence of easily observed root-hairs may be taken as an indication of the favourable physical state of the soil. The ground vegetation consisted mainly of a thick mat of a species of *Tradescantia*, and there was an even transition from the surface mould downwards into the lower depths of the soil. These several points together with the production history of the plantation may be taken as indications of exceptional soil fertility and suitability to the Gros Michel.

Again in some areas in Guatemala where the deep silt deposits were sufficiently high above river level and where deep and effective drainage systems were in operation, highly productive stands of bananas with long and good production records were observed. In comparable areas where the situation did not permit of adequate drainage and consequently aeration, both the production and the life of the plantation were diminished. Lastly in the good retentive loam soils in Colombia, where soil moisture is supplied by irrigation in the dry season, good annual yields and long production records were the rule. These three examples, then, indicate the existence of soils highly suited in their natural state to the requirements of the Gros Michel; thay may indeed be favourably compared with good soils in Jamaica which have been brought to a high standard of fertility by assiduous husbandry.

### VI.—Environmental suitability.

An inference which will readily be deduced from the observations set out here is that the Gros Michel banana is rather selective in its requirements and is frequently grown out of its environment. Compared with the Gros Michel many other varieties such as the Canary, Sucrier, Red banana, &c., appear to be much more tolerant of adverse soil conditions. Such comparisons have, however, a decided element of unfairness, in so far as these other varieties have not been subjected to similar long cropping tests. It might perhaps be said that, under the intensive cropping conditions in the Canary Islands, the Canary banana has been put to such a test. It must be realised however, that, while the soil in the Canary Islands is initially poor and shallow and general conditions adverse, the industry has prospered because of most careful soil conservation, cultivation, terracing, and the adequate use of manures, fertilizers and irrigation water [10]. In short the treatment of the Canary (Governor) banana in the Canary islands is analogous to the treatment of the Gros Michel on good properties in Jamaica, and both are alike in their long and good production records.

It has been seen that so far in the larger countries, where large areas of land are available the treatment of the Gros Michel has been by relatively crude extensive methods, whereas in islands, such as Jamaica, where the amount of land is limited, the treatment might be described as intensive—a contrast that is true for many crops. The same contrast is essentially true of the treatment of an important disease, such as Panama Disease in the case of the Gros Michel. Where land is plentiful it is generally found to be more profitable to abandon the infected or deteriorated land than to try and cope with the parasite or effect soil amelioration by detailed treatment. Thus Johnston [11] in a recent report on Panama Disease in Central America states "Studies conducted in Tela (Spanish Honduras) on two farms have shown that less disease resulted on the treated area than on the untreated, but the cost of the treatment was greater than the value of the bananas saved by the treatment, a discovery that has caused an abandonment of control measures excepting in special cases and has resulted in the saving of large sums formerly used for this purpose." Thus the policy of abandoning infected or deteriorated lands and the planting of new areas appears to be, at the present time, the most remunerative procedure, and presumably this will continue as long as land is available. If all the new land is ultimately used up and if banana cultivation is still continued, the problem of occupying abandoned lands will be met either by the use of an immune or highly resistant, hardy and adaptable banana, or by detailed treatment of different soils according to their requirements. Speculation is frequently in vain, but the future development of the banana industry in the larger countries will undoubtedly afford many points of great scientific interest

### VII.—Concluding Observations.

The Utopia of the scientific Agriculturist might be stated, perhaps, as one in which every crop was in happy relations with existing economic conditions, highly adapted to its environment,

and with alternative crops permitting of soil amelioration at reasonable expense. Already in this *Journal* Sir Norman Lamont [12] has quoted an example of an estate where a succession of crops, not suited to the environment and existing economic conditions, had to be abandoned one after the other. In this present article it has been shown that many of the areas opened for Gros Michel plantations during the past 30 years were not suitable for long and continuous cropping, and that soil deterioration set in after 4 to 7 years on the poorer soils and 10 to 14 years on intermediate soils. The alluvial plains which were usually explored for banana growing are by no means of uniform texture or fertility throughout. Some areas have proved so fertile that they appear to be able to support bananas almost indefinitely, but in close proximity other soils are found whose life in the absence of detailed treatment appears to be distinctly limited The principle adopted in the early days to test the suitability of new areas was to fell the forest, plant and await the result. Failures on account of sourness, heavy clay, high water-table, poor soil, bad material, &c., were common and the land was abandoned often without a second planting. Real insight into the problem was thus replaced by an expensive and destructive test. The justification of this procedure lay in the extensiveness of the field operations, and in the general success achieved, while agricultural and economic conditions were such that it was easier and cheaper to exploit new areas than to attempt to improve indifferent plantations by detailed treatment. After a longer or shorter period of intensive single crop exploitation comes the inevitable abandonment. This may be due to deterioration or disease. The alluvial land is first used up and then there is a retreat to the untouched hillside areas, where the life of plantations usually proves to be of still shorter duration.

At the present time these are the usual pioneer phases in the agricultural development of new lands in Central America. It is perhaps the only method possible under existing conditions. At the same time giant forests are destroyed; the native fertility of the soil is exploited to the utmost, and little or no effort is made to maintain or replenish it. But judgment of these matters is no easy task, and it must be left to the long arm of time to assign these agricultural methods to their proper category.

**Bibliography.**

1. Weitz, B. O. — An analysis of crop yield statistics with reference to soil deterioration. *Journ. Amer. Soc. Agron.* XVIII, 1926.

2. Howard, A. — Crop Production in India. *Oxford Univ. Press*, p. 71, 1924.

3. Wardlaw, C. W.—Report on a Visit to the Banana Growing Countries of the West Indies. Central and South America. *Empire Marketing Board*, 1929.

4. Thorne, C. E.—Restoring the fertility of a run-down farm, *Mo. State Board of Agr. Mon. Bull.* 5, No. 8, 1906.

5. Schreiner, O.—Changes in Character, Condition, and Amount of Soil Organic Matter. *Journ. Amer. Soc. Agron.* XVIII, 1926.

6. Walters, E. A.—St. L cia Banana Lands. *Trop. Agr.* Vol. VI, No. 3, 1929.

7. Prescott, S.—Examination of Tropical Soils. *United Fruit Coy. Bul.* 1918.

8. "R.C.M."—Fertile Soils. *Trop. Agr.* Vol. VI, No. 6, 1929.

9. Fawcett, W.—The Banana.—West India Committee. *Duckworth & Co.*, London, 1921.

10. ——*Bull. Imperial Inst.* Vol. XXIII, 1925, p. 168.

11. Johnston, J. R.—The Panama Disease or Banana Wilt. *Res. Circ. No.* 2, 1928, *United Fruit Coy.*, Boston, Mass.

12. Lamont, Sir N.—A Trinidad Plantation. A Century's Vicissitudes. *Trop. Agr.*, Vol. V, p. 167, 1928.

13. Waksman, S. A.—Principles of Soil Microbiology, 1927.

## MALAYAN GUTTA-PERCHA.

THE world's gutta-percha supply is derived entirely from the British and Dutch possessions and protectorates in the Malay Peninsula and Archipelago. For many years Singapore was the great entrepôt of the trade, but its relative importance has been decreasing for some time owing to the tendency for business to be done direct. The product provides the insulating material for submarine telegraph cables, and within the last year or so great strides have been made in adapting its insulating properties to the needs of submarine telephony and facsimile telegraphy. The two ends of the latest Transatlantic cable (from Newfoundland to the Azores), laid last year, and 1,341 nautical miles in length, extend about 160 miles from shore and have a core consisting of 500 lb. of copper and 300 lb. of gutta-percha per nautical mile. The next section, which is about 70 miles long on each end, has a core of 325 lb. of copper, 50 lb. of mumetal (an alloy of nickel, cobalt, and iron), and 270 lb. of gutta-percha per nautical mile. The main deep sea section has a core which contains 280 lb. of copper, 60 lb. of mumetal, and 225 lb. of gutta-percha per nautical mile.

The formation of gutta-percha plantations has not presented the same attractions to capitalists as rubber planting, but to assure maintenance of the supply one British cable-manufacturing concern grows it for its own requirements on an estate in Malaya, and is rapidly extending the area which it has under cultivation.

In their wild form, as they grow in the forests of British Malaya, the trees from which the best gutta-percha is obtained take 30 years to attain tappable dimensions Under cultivation, however, *Palaquium oblongifolium* may be grown as a shrub, in which case the gutta-percha is obtained by collecting and treating its leaves. — (*The Times Trade and Engineering Supplement*, Vol. XXIV, No. 568.)

# AGRICULTURE IN NORTH AFRICA.

(*Continued.*)

By V. H. W. Dowson, M.A., Dip.Agric. (Cantab.)

### Influence of French Civilization.

The energy and faith displayed by the French colonizers are remarkable. They do not doubt the success of their enterprise, or that their activities are for the greatest good of the greatest number. They are certain that French civilization is a better one than that of the lands they have conquered, and they do not hesitate to strive their utmost to supplant the latter by the former. Although, to those whose ears are accustomed to the self-deprecation and to the stern criticism of British policy prevalent amongst British officials in certain places, the complacent acquiescence in the theory of the divine rightness of all things French, at least in so far as they conflict with things Arab, may be discordant and too un-subtle, yet it would be difficult to deny that it is this attitude which has resulted in astonishing material progress in the backward land of Barbary. "The Philosophy of Doubt" has no place in the libraries of the *Gouvernement Général de l' Algérie*. With the uncompromising intellectual honesty of the French, those responsible for the destinies of Northern Africa have not had it concealed that it is for material wealth and power that France has come to this land. She is not there to help and to teach these three small and chaotic states out of an idealistic altruism; but she is there to make them as wealthy as she can, so that they may help share the burdens of the Republic.

This energy and this singleness of purpose have changed, and rapidly continue to change, the character of Barbary. From a turbulent pirate stronghold exporting nothing and importing only that which was stolen, Algeria has become a wealthy agricultural and industrial country; and in the two neighbouring states, a similar change is being effected. In the year when de Bourmont captured Alger, and laid the foundation of French dominion in North Africa (1830), the grain produced there was sufficient only for the needs of the local inhabitants. In 1919, Algeria exported to France alone more than three hundred million francs' worth of wheat. Algeria, nowadays, annually produces over two million *tonnes* of cereals. In 1830, there were no vineyards in Algeria: in 1920 there were over half a million acres under the vine.

Tunisia was proclaimed a French protectorate in 1881, and a similar, though smaller, increase in agriculture and commerce has taken place since that date. Between 1881 and 1889, the average annual exports and imports together were valued at twenty-three million francs. In 1920, they came to forty-two times that sum. In 1912, Morocco was proclaimed a protectorate. By 1920, the value of the external commerce was sixteen times as great as it was in 1908. Between 1913 and 1918, the revenue increased by five times.

### Land, Land Tenure and Taxation.

Before the conquest, North African agriculture was domestic and tribal. To-day, it is becoming commercial and capitalistic. The change from the non-intensive, semi-nomadic cultivation to the intensive system of European colonists is achieved not without bitterness. In the agricultural revolution that is occurring, the wandering Arab shepherds and the Kabyle wheat cultivators are being driven more and more into the less fertile and the less hospitable parts of the country. Not willingly have they given up their heritage. Nearly continuous fighting took place in Algeria from 1830 to 1847, when Abd ul Qadar was subdued. Then followed the wars which culminated in the capture of the Djukura in 1857. There were serious rebellions in 1870 and in 1917. In Morocco, there has been one continuous campaign, since the French first entered the country, in 1912, until the present day.

The old, self-contained, tribal units are being broken up assiduously by the new administration, and foreign settlers, cultivating specialised products, are sitting in their room. Some of the natives now work for wages in the lands they used to own, and some still try to live their old lives within boundaries sadly circumscribed. But the amount of grain exported has increased enormously.

The land is divided into the three main categories that are familiar to 'Iraqis, namely, *muluk*, *miri*, and *habus* (*i.e.*, *waqaf*). The majority of the first and last now belongs to colonists.

It is possible that that single act of the government which will prove to be most productive of agricultural progress in North Africa will have been the establishment of Land Settlement Bureaux. Claimants for settlement, or immatriculation, place their claim at the nearest office, together with the old title deeds, if any. The "Official Bulletin" then publishes a notice to the effect that any one having a claim against, or upon, the aforesaid estate must register it. The property next is surveyed and delimited in the presence of all claimants; and a further notice is published that the matter will be settled at a date four months distant. At the expiry of this period, the title-deed to the land is granted to the claimant, in the event of their being only one; or, if several dispute the possession of the land, the case is heard, and, on the finding of the court, the possession is awarded accordingly. Such a deed is irrevocable and an absolute title to the property. It is valuable for a colonist wishing to raise a loan on his land, and simplifies its future transfer; but its chief value lies in the feeling of security its possession imparts. The colonist, who has had his land immatriculated, knows that, whatever happens, he cannot be turned out of it; and, consequently,

has the strongest inducement to sink money in it to improve it. In Morocco, between the middle of 1915 and the end of 1917, two hundred and fifteen thousand acres were immatriculated.

Most of the revenue of Barbary comes as a direct tax upon agriculture. The *gross* standing crops are subjected to the iniquitous ten per cent. *ashar*, or government share. In France, the cultivator pays five per cent. of his *profits*, and, even then, feels injured. What has made the system of taxation in North Africa all the more deplorable is that, until the war, crops cultivated according to European methods were exempt from this tax, and its whole burthen fell upon the natives' crop. There was every encouragement to improve agricultural practice, it must be admitted; but, nevertheless, the Arab and Kabyle have become more and more impoverished. The latter, also, are the only part of the population called upon for the forced labour for guarding the forests and for anti-locust campaigning, for night guards outside towns, and for other duties. It is, indeed, a matter for surprise that the French, so keenly alive to the advantages of making their North African possessions flourish, should not have replaced the archaic and thoroughly bad Quranic system of agricultural taxation which they found upon their arrival.

**Agricultural Organization.**

In each of the three of the countries of Barbary, a department of Agriculture, Commerce, and Colonization has been organized, the composition of which varies somewhat in each.

*Morocco.*—In Morocco, it embraces the following services :—

Agriculture,
Veterinary,
Irrigation,
Commerce and Industry,
Agricultural and Industrial Chemical Laboratory,
Forests and minor services.

There are five agricultural inspectors, three botanical research stations, at Rabat, Meknes, and Marrakech, and three experimental farms, at Fez, Mazagan (Adir), and Marrakech (Menara). The Moroccan department is still in its infancy. That it should have been formed at all, in view of the continuous fighting that has taken place in Morocco, since the arrival of the French, is remarkable, and witness to the far-sightedness of the administrators of the protectorate.

*Algeria.*—The Department of Agriculture, Commerce and Colonization of Algeria, has been in existence for many years and has become a considerable organization. The agricultural leg of the triskelion is again divided into three :— Research, Education, and the Specialised Services.

The mycological laboratories are housed in the Pasteur Institute, but the botanical and entomological in the Agricultural Institute at Maison Carrée. The latter centre is now the headquarters of the Botanical Service, first established in 1894, at Rouiba, under the direction of the celebrated Dr. Trabut. The Rouiba Station, in the middle of magnificent vineyards, has been retained as a viticultural research centre. At Maison Carrée, is the main research station in the country, indeed, in North Africa. Under its jurisdiction is placed the Farm at Berteaux, where, in addition to the teaching work, new crops are tried under field conditions. There is an Experimental Station at Perrégaux, which is engaged chiefly in investigating cotton problems, and two stations, at Ain Ben Noui and at Djama for date research. Experimental Gardens are maintained in the larger towns of the country. Of these, the most famous is that at Alger (Hamma), founded by M. Hardy, in 1832, two years after the occupation of the town. The Veterinary Service maintains a Sheep Research Station at Tadmit.

The educational work of the department begins with the agricultural annexes to the primary schools (at Ben Chicao, Taourirt-Zouaou, Ammi-Moussa, and Mozouna), continues with the farm schools (Guelma, Orléansville, Mascara, Tiaret), and ends with the School of Rural Economy, or the School of Horticulture, both at Hamma, the School of Agriculture and Viticulture at Philippeville, the School of Agricultural Engineering at Maison Carrée, or with the Agricultural Institute of Algeria, also at Maison Carrée.

The specialised services comprise :

Meteorology,
Geology,
Agronomy,
Botany, and
Veterinary science.

The inspectors of the last three of these services tour the districts, and bring to the colonists the results of the research workers.

*Tunisia.*—The Department of Agriculture, Commerce, and Colonization in Tunisia was founded about thirty years ago, and hence, and also because Tunisia is a smaller and more backward country than Algeria, it is not so elaborately organised as that of the latter country.

The research section is housed near Tunis town, partly in the Pasteur Institute, and partly in, and near, the magnificent building (built in 1898) of the School of Colonial Agriculture. Here are the Parasitological Conservatory and the usual laboratories. Botanical and plant breeding research is the most generously staffed, largely owing to the energy displayed by its director, who has a number of trained assistants.

The educational work is confined to the school, already mentioned, and to the farm schools, one at Smindja, and one at La Smala-des-Souassi.

The general agricultural and veterinary services, composed of district inspectors, are under the control of a Director General of Agricultural and Veterinary Services, who is responsible to the Director of Agriculture, Commerce and Colonization.

## FUNCTIONS OF THE DEPARTMENTS OF AGRICULTURE, COMMERCE AND COLONIZATION.

### Causes of Success.

FRANCE is in Barbary : France stays in Barbary. Everyone knows it, and everyone acts upon it. There is an atmosphere of stability, security, and permanence about the administration of these three countries, which is refreshing, and which is productive of honest work. It is pleasant to meet agricultural officers, who regard Algeria as their home, and who look forward to spending the rest of their lives in the pursuit of knowledge and in the service of the country. It is this impression of permanence which strikes the traveller most forcibly.

The second of the many causes operating to make the work of these departments so extensive and so valuable is the support which they receive both from the governments and from the colonists. Alike among the civil administrators of the North and among the military *chefs du cercle* in the South is there a realization of the value of agricultural research and of propaganda, which, when encountered, is as welcome as it is unexpected. The colonists and large farmers are aware of the advantages of technical advice and avail themselves of it.

Thirdly, the department in each of the states has power to spend its budget in its own way. As once the grant has been sanctioned by the Councils, the department is free to spend it as it considers best. Receipts from the sale of shade trees, fruit trees, ornamental shrubs, flowers, improved vegetable seeds, pedigreed cereals, vine stocks, dates, and other produce are retained by the department and utilised for further production. The better the wheat seed issued to cultivators, for example, the higher the price obtained for it, and, consequently, the greater the amount of money available for increasing the work. There have been sold from the *Jardin d'Essai* at Tunis over two million bud grafts, plants, and trees.

Fourthly, the personnel of the departments is instructed, energetic and sanguine. The writer had the privilege of meeting twelve of the officers in the agricultural services in these three countries, who showed him much of what was engaging their attention at the time, and who thereby encouraged him in his belief in the possibility of revolutionising the agriculture of a backward country, provided those who attempt it are, like these, instructed, energetic and sanguine.

### The need for Research.

The foundation on which rest all the other activities of the government agriculturists is research. This excellent state of affairs the writer believes to be true at the present time ; but there are indications that it has become true only recently. It may be not uninteresting to insert here a translation of an outspoken criticism of agricultural policy in Algeria, made ten years ago.

" On examining agricultural administration during the last half-century, what is especially striking is the absence of all scientific method and of all spirit of continuity. At first, so as not to compete with France, Algeria is encouraged to produce silk-worms, cochineal insects, opium, cotton, coffee, &c. Then, following the examples of Australia and of Argentine where fortunes were made out of merino sheep, it was attempted to begin a sheep industry which, however, was soon abandoned, before any conclusions could be drawn from it. After the check to tropical crops, which a more careful study of climatic conditions could have predicted, and owing to a shortage of wine in France, following the *phylloxera* invasion, the colonists were persuaded to plant vines on a large scale, a scale out of all proportion, however, with the needs of local consumption, nor was there any prevision of their destruction, some time or other, under the same circumstances which had temporarily ruined the French wine industry, nor of the probability, and ultimate fact, of the latter's progressive recovery. Algeria lacks water, and the remedy is found in afforestation. But very soon, an irrigation policy is introduced, without, however, any of the preliminary researches on a scientific basis on which it should rest, and without which nothing durable could be produced, It is the era of the construction of the big reservoirs on the plains, soon to be abandoned by the very administration which had built them, which henceforward could see the solution of the difficulties only in the creation of barrages in the hills.

" When colonization first received official sanction, great efforts were made to secure labour and the door was opened to all Europeans, whether Germans, Irish, Italians, Spaniards, or any other, only to shut it again to all save the French, because the land was filled. Unlike the Romans before us, or, in modern times, the English in India and Egypt, and the Dutch in the Dutch East Indies, all this was done without any investigation into the possibility of obtaining help from the native population, a population completely sacrificed, and whose social organization and economics remain disdainfully unstudied. At the present time, there is preached the exhaustive cultivation of the soil by the growing of cereals and the planting up of land with olives, without any care to develop this latter interesting crop only in favourable parts, where it has a chance of competing against the influx of various oils from other countries, and where there is available plenty of labour for the picking of the fruit. In short, after three-quarters of a century of occupation, owing to the different policies followed, the great agricultural, economic, and social problems still remain unsolved.

" Without dreaming of those great agricultural institutes, endowed with millions, wherein the two Americas, in South Africa, in Australia, and especially in Java, scientific specialists, study the conditions necessary for the improvement

and development of the soil, could we not in our African possessions pursue the same course? When one thinks of the enormous sums, which, for the past eighty years, have been thrown away without achieving this object, and which, each year, are voted to our agricultural institutions, one can only regret that the question is not more advanced, that we know so little, from the scientific point of view, of our soil and our climate, that we are still only discussing the value of agronomical operations and the fertilization of the soil, and that we have not decided how to improve the cattle, how to improve the value of the land, nor how to solve the most important agricultural questions in rural economy and the fiscal regime. There is everywhere in the agricultural services the same penury of information, in entomology, zootechnics, zoology, agricultural chemistry, parasitology, rural economy statistics, and in the others."

These serious and somewhat unoptimistic critics (Messrs. Rivière and Lecq) regard the lack of centralization and coordination as the chief causes of the many mistakes enumerated. To a great extent in Algeria these wants have been filled. In Tunisia and Morocco, where the administrations have had the experience of Algeria as guide, they have never been so apparent.

**Plant Breeding.**

While Agricultural research is carried out in the various institutions already enumerated, its most important results have been achieved in the botanical bureaux, which have been fortunate enough, or far-sighted enough, to have as their directors in Algeria, Dr. Trabut, and in Tunisia, M. Boeuf. Dr. Trabut's fame is world wide; and, in order to indicate something of the scope of his own and his department's activities, the following may be mentioned.

The *Pelissier durum* wheat, one of the best and most widely grown of Algerian hard wheats, was selected many years ago by the learned doctor. It has been introduced successfully into the United States of America. One of the leading, white, wine grapes of the country, the *Clairette Egreneuse*, is one of his selections. To him is due the discovery of one of the wild pears, *Pyrus gharbiana*, which is used as a stock in most orchards in Algeria, and which is found more hardy and more satisfactory than the ordinary wild stocks of France. He, too, introduced *bersim* into Algeria; but, finding the bulk crop would not withstand the winter cold, was, after much trouble, fortunate enough to select a resistant strain; which is now being grown on a commercial scale. Sisal (*Agave sisalana*) hybrids are his work also. This plant, used for the manufacture of binder twine, would not withstand the low winter temperature of Algeria; but the descendants of a cross between this and an allied species have proved both resistant and of good quality fibre.

The breeding of cereals in Algeria is chiefly in the hands of Professor Ducellier, who was engaged, at the time of the writer's visit, in sorting out a *vulgare* × *spelta* $F_2$. Agricultural research necessarily suffers by being agricultural and not pure, but, occasionally, as in this instance, facts of more than practical value are brought to light. Professor Ducellier's work on these crosses is especially interesting at the present time in view of the recently published results of Sachs, Jezenko, and East on inter-specific crosses in *Triticum*. The Professor seems to have had much less than the usual difficulty in making these crosses, and in those between *vulgare* and *durum* varieties but his latest observations are yet to be published. In passing, it may be mentioned that spelt wheats are commonly grown in the date gardens of the southern oases.

Having begun his cereal work at Maison Carrée by collecting all the wheats of the country and of foreign countries that he could, the Professor has continued his economic work by trying to effect by hybridization the production of a wheat combining high yield and good quality with resistance to drought and to *Puccinia*. It is also to be a wheat which will not easily become laid. This ideal is still to be attained, but, nevertheless, several improved wheats have been put into the hands of the colonists. Wheats that pass the rigid tests of Maison Carrée are sent to the Farm Annexe at Berteaux for propagation; for it is realised that it is important not to allow a new and pure variety or strain to fall into the hands of ordinary cultivators or those not qualified to take adequate precautions to ensure its remaining pure, until a very large bulk of seed has been produced. From this thousand-acre government farm centre the pedigreed seed is distributed direct to the cultivators.

The centre for cereal breeding in Tunisia lies a mile north of Tunis, between the hills and the lake. Wheat, barley, and oats bred and tested here are grown on the Farm Annexe, which lies close by, and are thence distributed on payment to those cultivators who require them. One aspect of the plant breeding work carried out at this excellent institution, for which the writer could evince no enthusiasm, was a tendency, always more apparent in France or in the United States than in England, to reduce results of work to figures. Some activities lend themselves to this treatment, but plant breeding not easily.

Plant breeding in Morocco is carried out at the various *Jardins d'Essai*, and especially at that at Rabat, under the direction of M. Pochon.

This station was started in 1916, but little could be done until after the war. The results achieved in such a short time are remarkable. In addition to plant breeding, the work undertaken embraces fruit tree propagation; grape cultivation and distribution of stocks and grafts; the introduction and trial of essences (*e.g.*, carnation) and of drugs (*e.g.*, *Datura*); the propagation and sale of ornamental plants; the trial of entirely new crops, such as, for example, the Kei Apple (*Aberia caffra*); and research in market garden methods.

(*To be continued.*)

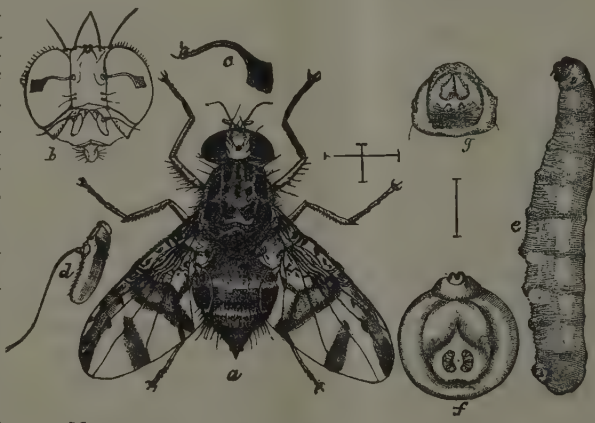
## ENTOMOLOGICAL NOTES.

*Compiled by the College Department of Entomology.*

### Fruit Flies.

*Life-History.*—Fruit flies occur throughout the temperate and tropical regions. Their food plants or host fruits are numerous. Certain species are restricted to one or a very few host fruits while others have a wider range. Fruit flies belong to the order Diptera, family Trypetidae, and comprise a large group of species which while differing considerably in size and form are alike in having rather striking colour patterns of yellow and black and in their habit of attacking fruit. They attack healthy fruit, before it is ripe; the egg is deposited in the tissues of the fruit by the adult female; the larva or maggot feeds in the unripe, or ripening pulp and when fully fed leaves the fruit, which usually falls from the tree, and forms its pupa in the ground. This habit of feeding distinguishes fruit flies from many other kinds of flies which attack ripe, over-ripe or rotting fruit. The injuries caused to fruits by the feeding of these flies results in rotting and the general breakdown of tissues, so that while the eggs of the fly are laid in healthy fruits, the maggots are often found in masses of rotting tissue.

*Distribution throughout the World.*—Fruit flies are among the most serious of agricultural or horticultural pests and the Mediterranean fruit fly (*Ceratitis capitata* Wied.) is considered to be the worst fruit pest in the world because of its wide geographical distribution and the long list of its host foods. This insect has been known as a serious pest of fruit for at least a hundred years and seems to be, without doubt, the insect that in the early years of the 19th century caused such severe losses to the citrus fruits of Mauritius, and to the shipments of oranges from the Azores to London. At that time the insect appears to have been established in Spain, Mauritius, the Azores, and Cape Verde Islands. It now occurs throughout the Mediterranean region from France to Greece, in South Africa, in Uganda and Egypt, in Australia, in South America, Brazil and the Argentine, Bermuda and the Hawaiian Islands and in April, 1929, it made its appearance in Florida.




Mediterranean Fruit Fly. (*Ceratitis capitata.*)
(*a*) *Adult.* (*e*) *Larva. Other letters refer to structural details.*

While the Mediterranean fruit fly has a recorded list of well over seventy food hosts it is chiefly a pest of peaches and oranges.

Almost a century ago it is believed that the Mediterranean fruit fly was responsible for the loss of the orange industry in the Azores from where as much as one-third of the total annual shipments of this fruit amounting to 90,000 to 100,000 cases were very badly damaged, some cargoes not even fetching the value of their freight. A profitable peach industry in Bermuda and a promising fruit industry in the Hawaiian Islands were completely ruined by the same insect. In Florida, it has been noticed that the pest is attacking grapefruit much more seriously than other fruits, and in orchards where only five per cent. of the oranges were attacked, grape fruit showed infestation amounting to 100 per cent.

In the Mediterranean region the intensity of attacks seem to vary from year to year and in Spain, Italy and Palestine crops of peaches and oranges are grown, and in South Africa and Australia also crops of these and other susceptible fruits continue to be grown even where the fruit fly is well established but where it appears to be limited in its range by temperature. It has been repeatedly introduced into England and is known to have reached New Zealand on several occasions, but has not become established in either of these countries.

In the more temperate portions of its range as in the Mediterranean region, Australia and South Africa the Mediterranean fruit fly varies in abundance from year to year. In the tropics as in Bermuda and the Hawaiian islands most varieties of fruits are so badly attacked year after year that, in the absence of control measures, only a few fruits can be obtained for domestic use by enclosing them when young in paper or in other impervious bags.

Fruit flies of various species are to be found in nearly every part of the world where fruit bearing trees and shrubs are grown, and many of these are important pests of cultivated fruits.

Most species have more than one host food though some appear to be restricted to very few. Many are to be found breeding in wild as well as in cultivated fruits. Some are limited in their geographical distribution to a restricted locality

and while no others are known to have the wide range of the Mediterranean fruit fly several species are well distributed. They often take a common name from the locality they inhabit or from the best known or most important of the fruit hosts they attack. Examples of these are the orange worm or Mexican fruit fly, which, as the name implies is principally a pest of oranges in Mexico. The melon fly which attacks melons and other cucurbitaceae. The Queensland, the Natal, the West Indian and the Central American fruit flies. There are also the apple maggot, the olive fly, cherry fruit fly and many others.

The Mexican Fruit Fly.

*Control Measures.*—In all countries where fruit flies are native to the place or where they have long been established, there seems to be some form of control, only partial in effect, which allows for varying infestations from year to year. This partial control appears to be due to the action of natural enemies and to climatic factors.

For many years the idea persisted that the Mediterranean fruit fly could be controlled by its natural enemies, and attempts have been made to introduce parasites or predacious insects from one country to another. In the Hawaiian Islands introduced parasites of the Melon fly are at the present time being bred under laboratory conditions and liberated in large numbers each season. The melon fly (*Bactrocera cucurbitae*) comes from the Far East and has been established in Hawaii for thirty years or more. It is a serious pest, and in addition to attacking the fruits of its host plants may attack young seedlings flower, root and stem and a large number of cultivated crops including tomato, string beans and cowpeas.

The artificial means of control of fruit flies which have been recommended and found satisfactory are:—cleaning up of all fallen fruits, and the use of poison baits. The first of these recommendations should be brought into effect wherever fruit flies attack cultivated crops. Infested fruits fall to the ground and there decay; the fruit fly maggots make their way from these fruits into the soil or rubbish on the ground and pass through their pupal stage. The regular and systematic cleaning up of all fallen fruit will do a great deal towards reducing the number of the adults in the following generation. In connection with this the destruction of wild plants which bear fruits liable to infestation is of importance.

Spraying for fruit flies involves a different principle from that in the spraying for the control of most insect pests. The spray is a poison bait for the destruction of the adult fly before egg laying takes place. In the case of the Mediterranean fruit fly and other species there is an interval of several days after the fly emerges from the ground before egg laying begins. During this interval the flies must take food and the object of the poison bait spray is to provide food containing a poison which they can consume during this period. The poison bait consists of a sweetened solution containing an arsenical. The formula which has been recommended for use in South Africa is as follows:—

6 pounds sugar.

6 ounces of arsenate of lead.

8 gallons water.

Orchardists who pay particular attention to the cultivation and protection of their crops have been successful in growing fruits free from infestation by the careful use of the two control methods enumerated above; but it will be realized that in localities with frequent and heavy rainfalls the use of poison spray is likely to be ineffective.

When the Mediterranean fruit fly was discovered in Florida the State and Federal Authorities took vigorous action, in an attempt to eradicate the insect. The first inspection indicated an infested area of about 80 square miles. Of cultivated fruits grapefruit was chiefly attacked, and while there were still large quantities of fruits remaining on the trees, a considerable portion of the crop had been gathered and shipped. The bulk of the first class fruit had gone by train to northern markets, but a very considerable amount of second grade or cull fruit had been shipped by auto truck to other points in the State and into adjoining states where conditions are such that the fruit fly might become established.

Legislation has been enacted which enables each infested area to be quarantined together with a protective belt surrounding it. Within this area all fruits liable to be infested are collected and destroyed. Wild plants bearing fruits which are known to be food hosts for the fruit fly are cut down to prevent their fruiting during the coming year. Ornamental plants, the fruits of which are liable to infestation are either destroyed or cut back to prevent fruiting. When this work has been completed in any locality, the soil in orchards where the fruit fly has actually been found will be sterilized by the use of steam.

## TROPICAL WORLD NOTES.

### *Haiti.*

France is the principal market for Haiti's leading export crop (coffee), and continued as the largest purchaser of Haitian products, taking 49.7 per cent. Other European countries took increased quantities, the most noteworthy instance being Italy, whose total purchases increased from 3.64 per cent. to 6.97 per cent. The United States has now displaced Denmark as the second most important market of Haiti, with a percentage share of 8.18. Denmark, which is the second leading market for coffee, took 7.72 per cent. of the total exports in 1927-28, and among the other important markets, gains were made by Belgium and the Netherlands, but there were smaller shipments of produce to Great Britain and Germany.—(*The Chamber of Commerce Journal*, Vol. LVII, No. 782.)

* * *

### *British Somaliland.*

Owing to the primitive state of agriculture in the country and to the total absence of any systematic cultivation British Somaliland is still a comparatively undeveloped country. Somalis, however, are for the most part a nomadic people whose principal wealth consists in their herds of cattle and in their flocks of sheep and goats. While conditions are to-day generally peaceful throughout the country, there is still a wayward tendency to indulge in inter-tribal cattle raids, which, from time immemorial, have been regarded as a legitimate pastime by all Somalis.

Much good work has been done on Government experimental plots to familiarize natives with the use of implements such as the modern plough and harrow, and with improved methods of agriculture.

The principal crop is sorghum, or Indian millet, which is closely allied to the sugar-cane. Investigations are being made to decide the best simple rotation to the millet which the natives have been in the habit of producing, but any economic results from such efforts must be a matter of time. As the result of the work of the Agricultural Department the cultivation of sorghum has been largely increased in the last few years, the imports in 1927 being no more than 661 cwt., whereas in 1923 no fewer than 15,644 cwt. were imported.

Agricultural interest in the country is confined to the interior plateau with its large open plains, since the coastal strip, which varies from a half-mile to 60 miles in depth, is hot, and has only a small rainfall.

Cattle thrive in the hills, and sheep and goats do well in years of average rainfall. The exports of sheepskins and goatskins to America and Europe in 1927, by way of Aden, were the largest recorded, totalling over 1,750,000 skins. The only other exports of note were gums and resins, ghee and salt, in comparatively small quantities. The export of gum is thought to be capable of development.—(*The Times Trade and Engineering Supplement*, Vol. XXIV, No. 568.)

### *Siam.*

According to Mr. G. R. Heasman, Acting Trade Commissioner, rice or paddy growing is the principal industry of Siam and accounts for 80 per cent. of the exports. It is also the staple food of the country. While rice is grown in all parts of Siam, it is the large area just north of Bankok that produces the major portion available for export. In the Northeast and Central sections the reaping is done with a sickle applied low down on the stems, which are afterwards threshed. In Southern Siam, however, the rice is cut ear by ear with a small knife. There are two outstanding handicaps to the use of machinery: first, the rice fields are not strictly fields but really just hundreds of small patches of ground, with divisions clearly marked by mud-walls a foot or 18 inches high, which keep in the water during flood season, or planting time and, secondly, the ground is usually too soft for wheels of any sort. Bound up closely with rice production is the problem of irrigation, and to improve and control a constant supply of water, the Siamese Government is doing and has done a great amount of irrigation work. Next in importance in world trade to rice growing are Siam's teak forests, which are exploited by a few large European firms who work under lease, and in accordance with Government regulations. These companies have built many miles of narrow-gauge track through their concessions to transport the timber to the rivers, where the trees are floated downstream to the saw-mills. Large herds of elephants are also used, and during the hot season when the elephants cannot work the natives use water buffaloes to haul the trees. Tractors are also used for this purpose. The other principal crops grown in Siam are sugar, cotton, rubber, pepper, and tobacco. The sugar industry is not very extensive. Pepper is a declining industry, while tobacco, though grown in all parts of Siam, is experiencing serious competition from cigarettes of American and Chinese make.—(*Commercial Intelligence Journal*, Vol. XL, No. 1323.)

* * *

### *Sumatra.*

The export of European plantation products increased only 6 per cent. in contrast with the rise of 26 per cent. shown in 1927. The production and export of rubber increased but little; this resulting from the fact that six years ago the planting of rubber was expanding but little, so that the productive area now shows a correspondingly small increase. The export of liquid latex increased largely, while that of sprayed rubber dropped from 16,611 tons in 1927 to 10,121 tons in 1928. The quantity of tobacco exported declined; tea shows a moderate rise; gambier exports increased, but this was counter-balanced by a fall in value; fibres show a decline of nearly 3 per cent.; and the only product showing a substantial rise was palm oil (and consequently palm kernels also).—(*The Board of Trade Journal*, Vol. CXXII, No. 1693.)

### The Leeward Islands.

*Montserrat.*

According to a recent report received from the Department of Agriculture, Montserrat, the cotton crop as a whole, showed decided improvement towards the end of the month of June when continuous rains fell for two weeks. The flowering and bolling of the crop was very heavy and apart from accidents an excellent crop should materialize.

*Nevis.*

Cotton picking was still in progress in June and in some places fairly good yields were being obtained from the second picking, and although there was a slight increase of pink boll worm, the pest has not been serious. The yield of cotton per acre has turned out very much better than anticipated and when the crop has been reaped will probably be over 200 lb. of lint per acre.

*St. Kitts.*

The Basseterre Factory produced 13,724 tons of sugar from 120,364 tons of cane, the yield of cane per acre being seven tons less than last year. The condition of the young cane crop is very satisfactory. There is every prospect of a good cotton crop owing to more favourable weather.

* * *

### Fiji.

The falling off in the yield of copra as compared with the record crop of the year 1927 was attributed to the drought in the previous two years and also to the effect of the Levuana moth outbreaks on Ovalau and nearby islands up to the end of 1925 from which the trees on these islands have not yet recovered. The Levuana moth has now, however, been brought under more or less permanent control by the importation of a *Tachinid* fly from the Federated Malay States, which in that country is parasitic on the related insect coming under the genus *Autona*. With a view to initiating a campaign to improve native plantations a report has been prepared which indicates that practically all these plantations could be greatly improved by a thorough cleaning of underbush, by thinning trees where these are too close together, and by improving the drainage system. With regard to the possibilities of discovering a system of artificial pollination a temporary officer has carried out work to see whether a routine could be evolved for keeping pollen viable for more than a few days, and secondly to make crosses between trees selected for their high productivity. A method has now been evolved for keeping pollen alive for ten days with some degree of certainty and crosses have been made on three types of coconut trees.

The gradual falling off in the export trade of bananas since 1925 is almost entirely due to the presence in a large number of native plantations of the banana borer *cosmopolites sordidus*. To control this pest a cleaning up campaign has been initiated whereby natives have been made to weed their plantations thoroughly and destroy them where they were beyond renovation, whilst new areas have been planted with suckers comparatively free from the banana borer. A feature of the campaign is that natives are required to destroy the stumps from which the fruit has been cut as it was found that such stumps were favourite breeding places of the beetle. Small shipments of bananas have been made throughout the year to Australia. Experiments in growing and canning pineapples have been made throughout the year and the product has received very favourable comment from a number of sources. The rice crop throughout the colony has improved very greatly and imports have fallen in consequence.—(Council Paper No. 75).

* * *

### Jamaica.

The Annual Report of the Department of Science and Agriculture for 1928 states that the year was a difficult and disappointing one. During the first six months the island experienced one of the worst droughts for many years, the rainfall amounting to only 63 inches or 13½ inches below average. Bananas and sugar were adversely affected, and stock owners had an anxious time, while in the southern and central areas lack of water caused a great deal of inconvenience to the people. The usual autumnal gales also took a rather heavy toll of the bananas, and the crop showed a reduction as compared with the record crop of the previous year of about four million stems. As there were a certain number of "rejections" of Jamaican bananas in foreign markets during the year, due largely to carelessness in handling the fruit, an Act entitled the Produce Protection Law was passed by Council, providing for Government inspection of fruit, and an order designed to regulate the export quality of bananas has been issued under the law to safeguard the position. Exports of coffee remained at about the level of the previous year, viz.: just under nine million pounds, while the value was about 25 per cent. greater than in 1927. Cacao did not do well owing to the drought, and production fell off to about 5,000,000 lb. weight. The common Jamaica "ordinary" cacao has improved, however, owing to the enforcement of the Produce Protection Law. Exports of both coconuts and copra declined slightly as a result of the dry condition prevailing early in the year, but a new industry was started in the production of coconut oil, and two factories are now producing this commodity for the local market.

Owing to the drought, only 48,714 tons of sugar were exported. With unattractive sugar prices some of the best sugar lands in Jamaica are being put into bananas, but there is a definite area of sugar lands where the banana cannot be grown successfully with a productive capacity of about 35,000 tons per annum, in addition to local requirements.

# DISEASES OF COVER CROPS.

By A. K. Briant, M.A., Dip. Agric., and E. B. Martyn, B.A.

[*During the season* 1927-8 *the writers, under the direction of Prof. H. R. Briton-Jones, made observations on the incidence of fungous diseases on five cover crops. A summary is given below of the diseases recorded, together with the experimental work carried out on diseases attacking sunn hemp.*]

## SUNN HEMP. (*Crotalaria juncea.*)

The diseases occurring on sunn hemp were: (1) a *Fusarium* wilt disease, (2) an anthracnose caused by a species of *Colletotrichum*, and (3) a *Cercospora* leaf-spot.

### 1. Wilt Disease.

This disease was first found in the East, having been reported in India by Butler (1), and in Tonkin by Vincens (2). Sunn hemp was originally introduced into Trinidad in 1924. The wilt disease now causes considerable losses on certain areas, especially when the crop is grown for seed production. For example, when the plants on the plots were five weeks old, 23 per cent. had already been killed, and most of the remainder either died before maturity, or were affected to such an extent, that the seeds which they produced were shrivelled.

*Symptoms.*—The symptoms of the disease vary according to the age of the plant, and the position of the infected area. When young plants are affected, the lower leaves wilt and fall off in succession from the base, and this is quickly followed by a wilting of the plant tip. Death then quickly takes place. Older plants often produce the same symptoms, but sometimes only a sector of the main stem is affected. In the latter case the overlying bark, a few millimetres in width and extending from just above ground level to a considerable distance up the main stem, is killed (*See* Plate I). Wilting of the adjacent lateral branches soon follows, but some weeks may elapse before the whole of the plant succumbs. A few days after the affected bark has been killed, it becomes covered with a pinkish mass of fungal growth. Microscopical examination shows that this colour is due to the presence of sporodochia of the fungus *Fusarium*, producing both macro- and micro-conidia. The infected wood, which is dark in colour, is permeated with hyphae, especially noticeable in the larger vessels, in which one-celled conidia are borne. The above symptoms never occur unless the root system is also penetrated with hyphae, and internally discoloured. On the other hand, the root system may be partially diseased while the stem is still healthy. Thus the root system is the seat of infection. The general tendency is for the hyphae to grow in a longitudinal direction in the vessels, and this, coupled with the infection of a lateral root, explains the occurrence of sectoral infection of the stems. The discolouration of the invaded wood is caused by the presence of gummy substances in the cells, deposited as a reaction against the presence of the parasite.

*Experiments.*—On making isolations from the junctions of diseased and healthy tissues of recently infected plants, a species of *Fusarium* was consistently obtained. Using this fungus as an inoculum, several infection experiments were carried out in the greenhouse. All the materials used were sterilised; the tins by washing in one per cent. copper sulphate solution, the soil and water by heating in the autoclave, and the seed by steeping in .1 per cent. mercuric chloride solution and afterwards washing. Typical symptoms of wilt disease were produced both by the inoculation of the soil with the mycelium and spores of the organism, and by their insertion into the collar of the stems. From these diseased plants the *Fusarium* sp. was again isolated. Controls, all of which remained healthy, were kept in both series. The experiments showed conclusively that the *Fusarium* sp. was pathogenic and the cause of the wilt disease in sunn hemp.

*Cultural Characters.*—The *Fusarium* producing sporodochia on the dead stems was also obtained in culture, and comparison on various media with that from the diseased tissues, indicated that the same species was involved. On malt agar a white mycelium was produced, which had a faint pink tinge due to the production of spores in mass. After growing for a fortnight on one per cent. acid rice, a brick-red colouration was produced, similar to that described by Butler (3) in the case of *Fusarium udum*. In all cultures both macro- and micro-conidia were formed, but the former were always in the minority and sometimes difficult to find.

*Spore measurements.*—The average size of the macroconidia from a five weeks old culture on potato agar was $40\mu \times 4\mu$, with an observed maximum length of $47\mu$, and a minimum of $29\mu$. They were mostly three septate, a few having four or even five septa. The microconidia varied considerably in form and size, and although usually continuous, some were one or more septate.

The spore measurements and general morphology of this fungus agree closely with the description and figures of *Fusarium udum*, which Butler identified as the cause of a wilt disease of pigeon peas in India (1, 3). Vincens (2) has already stated that a wilt disease of *Crotalaria juncea* and *C. usaramoensis* in Saigon is probably due to a species of *Fusarium* allied to *F. udum*, but he was unable to transmit the disease by artificial inoculation of the soil.

Wilt diseases of many genera of plants are now known to be caused by species of *Fusarium*, which are morphologically indistinguishable from *F. udum*. Slight variations in colour and form of growth certainly occur, but they are too

inconsistent to form a basis for classification. As regards their parasitism, Small (4) states that different strains vary somewhat in their ability to attack certain hosts, but that "pathogenicity depends less on the strain of the fungus—than on the environmental conditions prevailing when it comes into contact with the host." Butler (5) and Hansford (6) are now both of the opinion that it is preferable to regard all the *Fusaria* in the section *Elegans*, as being strains of a single species. Hence *Fusarium udum* is considered by Butler to be merely a strain of *Fusarium vasinfectum* Atkinson.

The Fusarium causing sunn hemp wilt in Trinidad does not appear to attack pigeon peas or cowpeas. For instance in the observation field, plots of these two crops adjoined those of the badly affected sunn hemp but no wilt disease was observed in them. Furthermore pigeon pea plants artificially inoculated with the *Fusarium* causing sunn hemp wilt gave negative results. It is evident, however, that the fungus described above, should be considered to be one of the strains of *Fusarium vasinfectum* Atkinson.

### 2. Colletotrichum curvatum, n. sp.

This disease has apparently not been recorded previously. It is essentially a seedling disease, and is of common occurrence in the Colony. The amount of damage which it causes is quite considerable, especially when the seed is sown thickly.

*Symptoms.*—The disease was first noticed on sunn hemp seedlings about two inches high, by the occurrence of brownish diseased areas on the hypocotyl and cotyledons. The lesions on the hypocotyl each consisted of a brown depression 4-6 mm. long and 1-2 mm. wide, surrounded by a brownish-black periphery. (*See* Plate II.) An infection at the base of the cotyledon, which was quite common, caused the whole cotyledon to shrivel and fall prematurely. Badly diseased seedlings often died, but usually the plants outgrew the malady, retaining more or less permanent lesions.

Microscopical examination of the surface of the depressed areas on the hypocotyl revealed the presence of the acervuli of a species of *Colletotrichum*. The discoloured cells of the outer cortex were permeated by mycelial strands, and the formation of a protective layer of cambium by the inner cortical cells had been induced. *Colletotrichum* fructifications similar to those on the hypocotyls, were found on diseased cotyledons, and also on the testae of some of the unsown seeds which were rather shrivelled in appearance.

Pure cultures were obtained by growing spores from the hypocotyls and the testae of the seeds.

To test the pathogenicity of the *Colletotrichum* sp. obtained from the seeds, several experiments were undertaken in the greenhouse. One of these experiments is described below. The seed used was selected from healthy-looking pods, and showed no sign of infection.

Three shallow boxes each about three feet by two feet, were washed with one per cent. copper sulphate solution and filled with sterilized sand. They were then sown thickly with seed, which had been treated in three different ways: *Box* 1. Seed immersed in mercuric chloride solution (.1 per cent.) for ten minutes and washed in sterile water. Control. *Box* 2. Seed treated with mercuric chloride as above. A suspension of the *Colletotrichum* spores was sprayed over the plants when they were one and a half inches high, and again after an interval of a week. *Box* 3. The undressed seed was immersed in a suspension of the spores.

The boxes were watered every day with a nutrient solution. When about a month old, the plants were pulled up for examination. All the seedlings in the control box appeared to be healthy, but in boxes 2 and 3 typical symptoms of the disease were apparent, from which the *Colletotrichum* was again isolated. The results of the experiment are tabulated below.

| Box. | Treatment. | Total No. of Seedlings. | No. of Diseased Seedlings. | Per cent. infection. |
|---|---|---|---|---|
| 1 .. | Seed dressed. Control. | 136 | 0 | 0 |
| 2 .. | Seed dressed. Seedlings sprayed with spores | 84 | 40 | 47.6 |
| 3 .. | Seed infected with spores | 114 | 31 | 27.1 |

As several other experiments were conducted which corroborated these results, the *Colletotrichum* must be regarded as a definite parasite, and the cause of the disease under discussion.

The infection of the seedlings by spores adhering to the seed coat suggested that a control of the disease would be attained by steeping the seed in a disinfectant such as formalin solution (1.320) for 10 minutes. This treatment however was tried on a small scale, and apparently had no effect. Consequently, it was concluded that the mycelium which grows inside the seed tissues and produces acervuli, is not killed by the dressing, and that it is also capable of causing seedling infection.

*Cultural characters.*—The fungus grew and fructified quite readily on the ordinary artificial culture media. On one per cent. prune agar the aerial portion of the mycelium was greyish-white. The surface of the medium soon became spotted with black acervuli, from which long dark setae were never absent. The spores were hyaline, falcate, acute at each end, and when viewed in mass appeared to be white with a faint pinkish tinge. They varied very little in size, the dimensions being (16-22)$\mu$ × 3.6$\mu$ with an average of 19.8$\mu$ × 3.6.$\mu$ The setae were brownish-black in colour, septate, tapering towards the tip, and measured (90-160)$\mu$ × (4-6)$\mu$.

*Identification of the fungus.*—As far as is known, there is no previous record of a *Colletotrichum* sp. with falcate spores occurring on sunn hemp. The fungus described above has therefore been regarded as a new species, for which the binomial *Colletotrichum curvatum* is suggested.

### 3. Cercospora Leaf Spot.

A zoned leafspot due to a species of Cercospora frequently occurred on mature leaves, but did very little harm.

## SWORD BEAN. (*Canavalia ensiformis.*)

This crop was affected by two diseases, neither of which was of any great importance. The fungus *Sclerotium rolfsii* caused the death of five plants only, and these occurred in different plots.

*Sclerotium rolfsii* has been previously recorded as a virulent parasite on a number of other crops, so that careful observations were made after its first appearance on sword bean. Of the five plants, three were left *in situ* to observe the rate of spread. In no case, however, was there any evidence of spread from plant to plant. This does not agree with previous accounts, and its failure to spread was probably due to the fact that the conditions under which the plants were growing, were not conducive to active parasitism by *Sclerotium rolfsii*.

*Soil Deficiency.*—The other malady which affected the crop caused small numbers of plants in patches to produce yellowish, slightly-rigid leaves with curled-up margins. As there was no evidence that a parasite was concerned, these effects were thought to be due to a soil deficiency. The following experiment supports this view. Two groups of the affected plants were treated with pen-manure and watered. Although no change was produced in the already existing leaves, the plants grew more vigorously and the leaves formed subsequently were perfectly normal in appearance. The diseased plants which received no treatment retained the original symptoms.

## COW PEA. (*Vigna catjang.*)

### 1. Mosaic.

Almost every cowpea plant in the field showed symptoms of a mosaic disease. The implication of a virus in the production of these symptoms, was established by the successful transmission of the disease to healthy plants in the greenhouse, under insect free conditions. The infections were produced by injecting the young stems with an extract from diseased leaves, by means of a hypodermic syringe. Other experiments indicated that species of aphides and jassids which were very abundant in the field, played no part in the dissemination of the disease.

### 2. Cercospora cruenta Sacc.

A leaf spot due to this fungus was very common on the older leaves, and frequently affected as much as half the leaf surface.

### 3. Oidium sp.

The oidial stage of a powdery mildew was observed only on the plants in the greenhouse.

## PIGEON PEA. (*Cajanus indicus.*)

### 1. Uromyces dolicholi Arthur.

This rust is common on the older leaves, but does not normally cause any appreciable damage to the crop.

### 2. Stem Canker.

A stem canker of pigeon peas is of great importance in Trinidad.

*Symptoms.*—The disease was first noticed on plants about two months old, by the occurrence of dead patches of bark on the main stem. Infection generally seemed to occur first in a small lateral shoot, from which the disease travelled down to the larger branch and formed the canker. On cutting open the stems, the wood underlying the lesion, and for a short distance above and below, was found to be dead and greyish in colour.

Microscopical examination of the discoloured wood showed that it was permeated by the hyphae of a fungus. Several isolations were made from recently infected plants, and in each case a fungus was obtained, which produced a dense greyish-black mycelium. Owing to the absence of any sporing stage, identification of the fungus was not possible.

## BENGAL BEAN. (*Stizolobium aterrimum.*)

### 1. Corticium vagum B and C.

*Corticium vagum* was responsible for the death of a large number of Bengal bean seedlings during the wet season.

### 2. Cercospora leaf spot.

A leaf spot up to $\frac{1}{8}$ inch in diameter and due to a species of *Cercospora*, was abundant on mature leaves. So far, the species of the fungus has not been identified.

### References.

1. Butler, E. J., Fungi and Disease in Plants.
2. Vincens, M. F., Une Maladie du Collet des Crotalaires au Tonkin. *Bull. Agric. de l' Instit. Scient. de Saigon.* III. 12. 1921. p. 381.
3. Butler, E. J., Wilt Diseases of Pigeon Pea. *Mem. Dept. Agric. Ind. Bot. Ser.* II. 1910.
4. Small, W., Notes on Species of Fusarium and Sclerotium in Uganda. *Kew Bulletin*, 1925, p. 118.
5. Butler, E. J., Wilt Diseases of Cotton and Sesamum in India. *Ag. Journ. India.* XXI. 1926. p. 268.
6. Hansford, C. G., *Proc. Ninth W. Ind. Agric. Conf.* 1924-25. p. 43.

## GOLD COAST COCOA.

*[We publish below a summary together with extracts of an article which appeared in Vol. L V I, No. 6, of the "Tea and Coffee Trade Journal" on The Progress of the Gold Coast Cocoa Industry, by Mr. A. W. Paterson—Gold Coast Provincial Superintendent of Agriculture.]*

The Gold Coast is now the largest cocoa exporting country in the world and in 1928 produced 225,322 tons of cocoa out of a world's estimated production of 500,000 tons. The very remarkable growth of this industry is revealed by the fact that only 80 lb. of cocoa were exported in 1891, which figure had grown to 39,726 tons by 1906, to 133,195 tons by 1921, and to 225,000 tons by 1926. It is estimated that out of a population of over one and a half million the actual number of persons engaged in the cocoa industry is in the region of one million, and the production per able-bodied man is calculated at 16 cwts. of dried cocoa. The cocoa industry is purely a native one, there being only one plantation in bearing at the present time under European management. The important seasons to the cocoa farmer are the Harmattan * and rainy seasons. A very long and severe Harmattan may cause partial defoliation on the more exposed farms. The wet season should be sufficient and well spread out and the shorter the period between the small and big rains the better for the following crops.

Ever since cocoa was introduced the Government has done all it could to encourage and develop the industry. Agricultural Stations were established at various places from which large quantities of seed were distributed and the best methods to plant, prune and prepare the cocoa for market demonstrated by both European and African Agricultural Officers. Legislative measures to control pests and diseases were also gradually introduced and the Plants (Injurious Pests) Ordinance became law in spite of considerable opposition.

### Establishing a Cocoa Farm.

The usual method adopted by the Gold Coast farmer to establish a cocoa farm is to clear an area of one to five acres, the size of the farm depending on the energy of the farmer himself and on whether he can afford to employ outside labour or not. The undergrowth is cleared first by cutting and burning and the trees felled—with the exception of some of the more valuable species which may be left to act as shade trees. The branches of the felled trees are lopped off and, with all the smaller wood, burnt. The stumps, however, are not removed, but, with the trunks of the larger trees, are left to rot and to these can be traced most outbreaks of root diseases. When the clearing has been completed, corn is sown which is interplanted with plantains and coco-yams. During the previous small rainy season, a cocoa nursery has been made near a stream in a damp shady site and the young seedlings are planted out during the next main rainy season, the food crops acting as temporary shade, as well as providing a supply of foodstuffs. Although the cultivation given to these crops is generally restricted to rough cutlassing or hoeing, the young cocoa seedlings benefit from it and are given a chance of becoming established.

### Trees to the Acre.

In planting, the Gold Coast farmer does not trouble to line his plantation as this would be difficult on unstumped land with a crop of corn already occupying the land, but he succeeds in planting with fair regularity in spite of all these difficulties. Owing to ignorance much of the cocoa on the Gold Coast is too closely planted. As many as 1,100 trees have been counted on an acre, 600-700 per acre not rare and 500 common.

### Pruning Methods.

After the plantain and coco-yam crops have been reaped the farm is allowed to revert to "bush" until the young trees commence to bear a few pods. The farm is then thoroughly cleared of all growth other than cocoa and such shade trees and oil palms which were left when the original clearing was made. Despite the straggliness of these trees at this stage they grow quickly and in a year or so develop a canopy. The Gold Coast farmer's idea is to have his cocoa with long bare stems six to eight feet high without any branches below that height so that he can easily pass through his farm to reap and collect his pods.

To attain this type of tree the lower branches are removed. The regrettable part of this practice is that, because they are bearing or may bear a few pods the basal six to eighteen inches of the branch are left projecting. These spurs which are neither tarred or treated in any way naturally die back and this spreads right into the main stem giving rise to large cavities which must and do reduce the strength of the tree. The average farmer has no idea of cultural pruning. The habit of thinning the crown of the tree to let in light and air to the lower branches results in the death of these branches and this adds naturally to the length of the bare stem.

No cultural operations are followed other than merely roughly cutlassing the weeds around the trees just before the crop is ready for harvesting in order to facilitate that operation. On a large number of farms this is not even necessary as the overhead canopy is so dense that nothing will grow under the trees—and these are some of the best farms. The reason is that the dense

* The Harmattan season occurs round about December and January. During this period the maximum diurnal variations in temperature occur and are accompanied by a very dry dust laden wind from the North. These conditions are not continuous but occur in spells of from one day to several weeks in duration.

over head canopy protects the soil and the roots of the trees from the direct rays of the sun and so enables the trees to withstand the drought of the Harmattan period better than if the soil were exposed.

### Picking.

The pods are not, as they should be, collected when they are just ripe but three pickings at roughly monthly intervals are made of ripe, over ripe or just about ripe pods. Large heaps of these pods are then made and broken any time from one to four days after reaping.

### Fermentation Boxes.

Fermenting places are generally prepared on the farm but only a few farmers ferment their cocoa in proper boxes arranged on the three tier system. Single boxes or large baskets lined with plantain leaves are often used but most of the fermenting is done on the ground. By this method plantain or banana leaves are simply spread on a clean piece of ground and as the pods are broken the beans are thrown in a large conical heap. A rough box, without top or bottom is sometimes constructed with plantain stems twelve or eighteen inches high or with palm mid-ribs; these help to make the fermenting heap more compact and are for that reason preferable. Holes are also dug, about two feet deep which are lined with plantain leaves and used for fermenting but the objection to this method is that if there is any rain the holes may become filled with water which spoils the fermentation, while the mucilaginous juices have little chance of draining off.

All fermenting places are lined with plantain leaves and if the cocoa is turned regularly and thoroughly and is sufficiently covered to retain the heat generated and to keep out any rain that may fall, quite a good quality can be produced.

The Gold Coast with its large numbers of small farms cannot aim at producing a plantation grade of cocoa but it can produce an article which is of such a quality as to meet a ready sale in all the cocoa markets of the world.

When the cocoa has been fermented it is carried to the drying racks. These are rough platforms two to three feet high made with bush sticks and covered with mats locally made from the mid-ribs of the Raphia or oil palms; even cement drying floors have been made by some enterprising farmers. The cocoa is spread out and in suitable weather may be dry in about a week.

The chief fault of the farmer's methods of preparation is that he does not turn his fermenting cocoa as regularly nor as thoroughly as he should, with the result that in the finished product a proportion of beans are over, under, or not fermented at all.

### Labour System.

Work on the cocoa farms is carried out in several different ways—by the farmer and his family, by communal labour and by labourers employed on various systems of remuneration. The first system is general where the farms are small and in the less developed districts. The second method is found where the farms are larger and where at the time of harvesting each farm is dealt with in turn; the produce is the property of the owner of each farm.

Where labourers are employed various systems of payment are to be found; some are paid a monthly wage when the crop has been sold, the farmer providing free food and accommodation. In other areas, particularly where the farmers have farms some distance apart, the labourers undertake to look after the farms and do all the necessary work and receive one-third of the total crop sold. This system is only general on the older and less productive farms. On the younger and more productive farms the labourers who work from July to March, doing all the weeding, pruning, harvesting and preparation of the crop, are paid at the rate of 2*s*. 6*d*. per load* of cocoa sold from the farm.

As these labourers, who generally come over from Togoland, return year after year to the same farms, they build their own houses on the farms and have their own little food plots on the land belonging to the owner. When these labourers return to their homes they make food farms, the produce of which is either sold before they return in the case of corn or sold by their families later in the season.

Where the labourers are only engaged for the actual harvesting and preparation of the crop the rate paid per load of cocoa is 1*s*. 6*d*.

The average yields of Amelonado from the several agricultural stations on which cocoa has been grown, were 595 lb. of dry cocoa per acre over a period of sixteen years from an area of 3.23 acres at Aburi. The same station holds the record for the highest annual yield, having produced 1,627 lb. of dry cocoa per acre in 1917. In 1918, Plot IV—10 acres—at Assuantsi station yielded 1,584 lb. per acre.

### Marketing of Cocoa.

Cocoa is universally bought on the Gold Coast by the load of 60 lb. and the price quoted to the farmers is for that quantity.

The produce is generally sold, except by the more progressive farmers, to local brokers who are to be found in every village of any size if it is on or near a motor road. These brokers are either free buyers who sell in the afternoon to the firm offering the highest price or are buying for a contractor or an exporting firm who give them a price delivered at their store, cash, bags, &c. and they have to show cocoa against the amount given or account for the money. When the market is unsteady the lot of a buying agent for one of the large firms is no sinecure, as with each change in the price he has to go to each of his buyers, check their stocks and fix the new price. The news of a change in the price of cocoa travels through the country at an

* Load = 60 lb.

amazing speed and despite the fact that each firm uses an elaborate telegraphic code the buyers in the "bush" appear to get to know that a change is coming even before the agent can get out there in his motor car.

### Plant Sanitation.

When the Plants (Injurious Pests) Ordinance was introduced elaborate machinery was set up at first to control diseases and pests but it was soon found that the work to be done took very much more time than had been anticipated and now the various systems tried have been changed to one of treating and demonstrating in a small area of about an acre at each village. Prosecution may follow six months after demonstration if action has not been taken on farms, while after twelve months if the condition still remains, the Inspector may do the work at the expense (which is recoverable) of the owner.

### Future of Cocoa Industry.

It is the opinion of most people that the Gold Coast cocoa industry has now reached the peak of its production owing to the incidence of the following limiting factors: population, new area available, exhaustion of older farms, native methods of farming, pests and diseases, deforestation. Potential areas available for developing still exist, but at the present time there is not the population there to develop them as has been done in the more densely populated and, at present, more developed areas. The extension of motor roads into these areas such as the Dunwa-Wioso and the Kumasi-Sunyani Roads will undoubtedly lead to greater production there in a comparatively short time. The exhaustion of farms, which is now occurring in the older areas will no doubt in time lead to a migration of farmers from these areas to those less developed and a consequent increase in the rate of development may take place and the production be maintained at a high level for a long period.

Deforestation and the encroachment of the savannah on the fringes of the forest area are having a very serious effect and the Government for years has been attempting to get the Chiefs to set aside portions of their lands as Forest Reserves, the idea being to protect steep slopes, and to preserve water supplies and atmospheric humidity. Some places, where even present European members of the Department can remember cocoa thriving and producing good crops, are now pure savannah with no vestige of cocoa within a considerable radius. The lack of shelter due to the wholesale destruction of forest which should have been left as shelter belts is having a serious effect on many of the more exposed farms and these are suffering more severely each season from the lower humidity and the effects of the Harmattan and naturally cannot be expected to maintain profitable production for so many years as would otherwise have been the case.

The effects of deforestation in conjunction with disregard of the exposure of the land are very clearly seen on some farms, and severe attacks of thrips and other insect pests are a natural result.

Another serious aspect of farms which have no shade is where a tree has been lost through any cause such as root disease. A hole is left on the farm which, like an untreated ulcer, gradually extends, grass becomes established, and insect pests and the effects of the sun on the exposed soil and roots of the neighbouring trees soon make themselves felt to the detriment of the farm. In such places, particularly where there have been cases of root diseases, it is inadvisable to plant any trees liable to the disease, but the immediate planting of temporary shade such as plantain and coco-yams with the filling of the vacancy by some useful immune permanent plant as oil palm is recommended. However, it is seldom carried out by the farmer.

The utilization of so much land for cocoa growing has had the effect of causing a shortage of foodstuffs in some of the older cocoa areas. The wasteful system of shifting cultivation coupled with planting of cocoa on all cleared land has had the result of leaving no suitable land for food farming and in many places large quantities of foodstuffs have to be imported from less developed areas or from areas outside the cocoa belt. Yams, for example, are grown in large quantities in the Ho and Kpandu districts of British Togoland and these are brought over in lorry loads to the Gold Coast, distances of up to 140 miles. This is specialization carried to a ridiculous extreme, but still from many points of view it is not altogether undesirable as it provides a market for produce from these areas which otherwise would be unsaleable.

The future of the Gold Coast cocoa industry is dependent on the maintenance of the already established farms and on the improvement of the quality of the produce exported rather than on the planting of new areas, and work to this end has already been started by the institution of manurial experiments, the Plants (Injurious Pests) Ordinance, the Forestry Ordinance and the inspection of produce of the port of shipment which will come before long.


## PUBLICATIONS FOR SALE.

Copies of the following publications may be obtained on application to the Editor, Imperial College of Tropical Agriculture, Trinidad, B.W.I.

SUGAR COST ACCOUNTS ..By G. C. Skinner, Price 1s.

EXPERIMENTAL ERROR ..By E. J. Maskell, Price 1s.

THE SUGAR INDUSTRY OF THE WEST INDIES AND BRITISH GUIANA, WITH SPECIAL REFERENCE TO TRINIDAD ..By C. Y. Shephard, Price 2s.

## EXCELSA COFFEE.

*[Reprinted below are extracts of an article by T. B. McClelland which appeared in "Agricultural Notes," No. 45, published by the Porto Rico Agricultural Station, Mayaguez. Excelsa coffee has proved particularly promising for planting under certain conditions and the following information about this variety should be of interest to planters.]*

Excelsa coffee was discovered abour 25 years ago in West Africa and introduced by the Dutch in Java where hundreds of acres are now planted with it. Java seeds of Excelsa coffee were planted at the Mayaguez station in November and December, 1915, and the trees are now showing something of what may be expected of this variety.

It is stated that Excelsa coffee can be adapted to a dry climate and that it has been found in one locality with a six-month dry season and an annual rainfall of 40 to 60 inches.

In the wild state it grows in forests below 1,650 feet altitude and this natural range is presumably the best suited to it. Dr. Cramer of Java says that while it may be grown at more than 4,000 feet it would hardly pay at that altitude where the growth is much slower.

Excelsa may be grown with or without shade, an important adaptability at the present time with the shade trees so extensively damaged or destroyed by hurricanes. At the station it has grown well under both these conditions. In Java it is said to be grown generally with shade, but a lighter shade is preferred for it than that used for other coffees.

Though Excelsa coffee will, of course, grow better in a rich soil, it does not require it, and will flourish in soils unsuited to the best development of Arabian coffee. The root system is notably strong and vigorous, and from the older trunks large roots may be traced far out from the tree.

In the wild state Excelsa coffee is a tree from 27 to 50 feet and even sometimes 66 feet high. Grafted trees at this station have attained a height of about 23 feet in nine years. The growth is very vigorous and the trees attain so large a size that they must be widely spaced. On one of the station fields the branches of 13-year-old trees spaced 12 feet apart now meet. A closer permanent spacing than 12 x 12 feet would seem inadvisable. However, where the seed supply is abundant and land scarce, trees can be planted closer and alternate ones removed as the growth warrants. In this way the earlier crops will show a higher yield per acre, but the planter will likely have difficulty in persuading himself to destroy perfectly good trees when they begin to crowd one another.

It is readily seen that the picking of the crop from trees so tall as Excelsa is not an easy matter when the field is on a steep slope. Even though most of the trees at the station have been topped at 12 feet, ladders have had to be used and where there are steep slopes the trees should be kept at such a height as to make ladders unnecessary in harvesting the crop, even though the lower heading-back of the tree should result in a somewhat reduced production. On more nearly level land where ladders can be used trees should not be allowed to grow above 12 feet in height, as if this is done before the trees are topped, there will have been a loss of irreplaceable lower primary branches. The initial topping should be when the tree is small and still retains the first primary laterals. When four pairs of laterals have developed is a good time to top. Growth will then be forced into the laterals and they will develop into large brances. When they have become strong and well developed, an upright branch may be allowed to grow from the trunk and carry the growth up to the desired height.

The leaves of Excelsa coffee are of a much stiffer, heavier texture than those of Arabian coffee and are larger, measuring 8 to 12 inches in length and 4 to 6 inches in breadth. They are much less subject to injury from the leaf miner which when it enters makes little headway. For localities where the ravages of this pest are excessive, the planting of Excelsa coffee rather than Arabian is recommended.

The crop begins to ripen in December or January and continues into the following summer, thus ripening in the months when the Arabian coffee is not being picked and when labour is most readily available on the coffee plantations. It is much less liable to loss from over-ripeness than Arabian coffee, and in consequence there may be longer interims between harvesting periods. The ripening season coincides with the drier weather, which favours the picking of the crop. Since the cherries are quite immature and many of them still small in the hurricane season, the probability of wind damage to the crop is less than in the case of Arabian coffee, provided, of course, that the tree itself is not broken, blown over, or killed.

The pulp is firmer and less juicy than that of Arabian coffee. It is thinner, however, than that of some other members of the Liberian group to which Excelsa belongs, and the machinery ordinarily used in pulping Arabian coffee may be used for Excelsa.

The cherries on the average are smaller than those of the Porto Rican coffee but there is little difference between the two in bean weight. The loss in weight on removal of parchment is about 26 per cent. for Excelsa in contrast to 17 per cent. for Porto Rican. While an almud of cherries of Porto Rican coffee is generally considered as the equivalent of five lb. of coffee beans after removal of parchment, an almud of Excelsa gives but four lb. of cleaned coffee. This makes the picking of Excelsa relatively more costly. The total reduction in weight from cheerry to marketable bean in samples prepared at the station was in the ratio of 7.2 to 1. That is, for one lb. of coffee as marketed, 7.2 lb. of coffee cherries were picked.

The bean totally differs in appearance from Porto Rican and for marketing purposes the two should not be mixed. The silver skin is of a pale brownish colour and the bean is straw-coloured or yellow. A considerable portion of the silver skin adheres to the beans giving them a rough and uneven appearance, unless they are rapidly dried by artificial heat. A fragment of the parchment is likely to be held in the deep sutures, which also detracts from the appearance.

The quality of the beverage prepared from Excelsa coffee is good and would be acceptable locally. On the markets this coffee could not be sold as Porto Rican, to which it is much inferior in appearance, but would be classed presumably as Liberian, to which it is more closely related.

Excelsa coffee trees begin to bear at five to six years from the time of planting the seed, although no large yields were obtained at Mayaguez until they were eight years old. On one plot thirty-seven trees from eight to twelve years old, planted 12 x 12 feet, produced the satisfactory average yield of 671 pounds of coffee per acre (parchment removed). On this plot the trees were topped at 12 feet when a little less than seven years old. On another plot where the trees had been topped late and had been grown with too heavy shade, the yield was not quite as satisfactory. The soil in which the trees were grown was certainly not superior in fertility to that of the average coffee plantation, and some of it would be considered very poor. No fertiliser had been applied to it.

**Summary.**

Excelsa coffee is less exacting in its shade requirements than Arabian coffee and may even be grown without shade. Its adaptability to a dry climate renders it less subject to injury from a protracted dry season. The vigorous root development and robust tree growth even on poor soils indicate this to be a promising variety for planting in many localities less suited to the more exacting Arabian varieties. Its resistance to the leaf miner is an attribute of paramount importance in some sections. The yield is comparatively high and the crop, ripening as it does in the drier months of the year, is much less liable to loss through wind or rain. The cup quality is good.

Against these good points, there are several less favourable characteristics. Excelsa is late in reaching full production. The reduction in weight on curing is high, an almud giving four instead of five lb. of cleaned coffee. On account of the less attractive appearance and the smaller established demand for coffee of this type, the product would be less readily marketable at a good figure.

---

We have to acknowledge with thanks the receipt of a pocket catalogue, section 2, recently issued by Messrs. Stewarts and Lloyds, Ltd., which contains a mass of useful information on the uses of their joints fittings.

## TSETSE FLY RESEARCH.

THE following brief summary of research on setse fly control in Africa, by Dr. John Phillips, Deputy Director and Ecologist of the Department of Tsetse Research in Tanganyika Territory, is published in *Ecology*, Vol. X, No. 3. The basis of attack on this dreaded insect, which through spreading sleeping sickness has depopulated large areas of Africa, is that of dynamic ecology. The aim is to obtain basic information on: (1) The nature of the behaviour of the tsetse fly under certain sets of conditions; aerial, edaphic, zoobiotic, and phytobiotic; (2) the mechanism of behaviour under certain sets of conditions: (3) the periodicity of the nature and mechanism of behaviour; (4) the causes producing the nature, mechanism, and periodicity of behaviour; (5) the particular ecological factors, singly or in complex, influencing the nature, mechanism, periodicity, and cause of behaviour; (6) the manner of application of the foregoing information in controlling the tsetse fly.

The chief lines of investigation have been: (1) Observations upon the fly's density—activity, breeding, and general behaviour in relation to season, weather conditions, vegetation, game, and man. The data indicate the existence of centres of denser fly population with a higher proportion of female flies. (2) The autecology of the tsetse fly. (3) The synecology. Information necessary in experimental studies of the ecology of fly communities has been obtained. (4) The inter-relations of the fly, plant, and animal communities, and the physical environment. A series of stations has been installed in representative plant communities, either favoured or avoided by the fly, and the physical and biotic factors are being recorded by quantitative methods. (5) The relations of the fly to game. There are indications of a relation between the presence of herds of large game, and fly centres. (6) Alterations of environmental factors in controlling the fly. The factors of temperature, light, evaporation, and food are being experimentally altered by increasing the density of the vegetation on the one hand, and decreasing it on the other. (7) The direct and indirect influences of fire in control work. Observations support the view that fire causes high mortality in the pupae, but does not harm the adult fly. (8) Biological control. One parasite has been found which attacks large numbers of the pupae. (9) Biological collections. Considerable numbers of plants, insects, and birds have been collected.

One readily realizes the enormity of the problem, and the length of time which will be required to find a weak spot in the complex inter-relations between the insect and its environment before reasonable methods of control can be advised. It is of more than passing interest that no attention whatever is paid to the risk which this study involves of contracting the disease carried by the tsetse fly. The danger seems to be taken as all in the day's work, and completely ignored.

## REVIEWS.

Engineering for Forest Rangers in the Tropics. By A. H. Lloyd. Oxford, at *The Clarendon Press*, 1929, pp. 228 + XVI (with 32 photographic plates and 85 diagrams). *Price* 17*s.* 6*d.*

This is altogether an excellent book and, although written primarily with a forestry bias, it contains much common sense practical information which should be of value to all whose work lies in developing tropical lands.

The scope of the work will best be gathered by stating that (in round figures) 30 pages are devoted to notes on materials, carpentry joints and fastenings, 30 to the construction of simple buildings, 60 to roads, 40 to bridges and culverts, and the remainder to transport and miscellaneous matters.

The chapters on road work are particularly good bringing out in an easily understood way methods of alignment, construction, drainage and metalling.

The book, the author states in his preface was "primarily designed to serve as a Manual in Forest Engineering for students at the Burma Forest School," but there is no doubt that it will have a far wider range of utility than this, and it would probably be of much assistance to agricultural officers.

There is one error on page 187 in which a cubic foot of water is stated to weigh 6¼ lb. whereas the correct weight is 62.5 lb.—presumably the decimal point strayed.

The author is now Lecturer in Forest Engineering, at the Imperial Forestry Institute, Oxford.

R. C. M.

* * *

Pests and Diseases of Queensland Fruits and Vegetables, by Robert Veitch, B.Sc., F.E.S., and J. H. Simmons, M.C., Department of Agriculture and Stock, Queensland, pp. 198.

This attractive book gives brief and useful accounts of insect and other pests and diseases of vegetables in Queensland, with directions for treatment and control. There are sixty-four plates, some of which are coloured, reproduced from drawings, paintings and photographs. The opening chapters present elementary information in entomology and mycology.

The pests and diseases of deciduous fruits, citrus, bananas, pineapples, tomatoes and vegetables are discussed under appropriate chapter headings; and there is a chapter on general feeders, pests and diseases, that show a wide range in their host selections.

The excellent insect plates would be even more valuable if a comparison were made between the natural size of the insect and the size of the reproduction.

H. A. B.

Report on the Mazaruni and Puruni Diamond Fields of British Guiana. By H. J. C. Conolly; *Crown Agents for the Colonies*, 1925. With 11 maps and 11 diagrams.

The first authentic discovery of diamonds in this now famous district was made in 1887. In 1890, some 750 diamonds were found there, in spite of the fact that the great distance of the area from the coast (130 miles away), prevented rapid development of the fields. Various syndicates have since exploited the area, but, in 1913, most of the companies had closed down for various reasons, and "pork knocking" commenced. During the War, all stones had to be sent to the United Kingdom by Royal Proclamation. In 1919, a threefold increase in the purchase price of diamonds led to revived activity, but this was diminished again by the much lower prices realized in 1920. In 1921 and 1922, a rally in prices caused renewed exploitation, and the discovery of several new fields brought about much land-grabbing. The population rose to 10,000 in 1923, but it has since fallen, and the diamond output has steadily diminished. The proved diamond-bearing area extends over 1,200 square miles. The survey described in the Report was undertaken in order to assess the economic resources of the area, to ascertain whether valuable minerals other than diamond occur in the alluvial deposits, and to provide exact field data for the use of prospectors. Its comprehensive scope will appeal to all who are interested in the natural wealth of British Guiana. Doubtless the successful exploitation of the mineral resources of the Colony will furnish a financial aid to the development of its other industries, including agriculture.

F. H.

## BOOKS RECEIVED.

We have to acknowledge the receipt of the following books:—

**AGRICULTURE.**

**Sugar-Cane and Its Culture.** F. S. Earle. John Wiley & Sons (*Chapman & Hall*), p. 356. 22*s.* 6*d.*

**BOTANY.**

**The Anatomy and Physiology of Hevea Brasiliensis.** W. Bobilioff. *Art. Inst. Orell Fussili.* p. 150.

**GENERAL.**

**Agricultural Education in the United States.** W. H. Shephardson. p. 132. *The Macmillan Co.*

**MYCOLOGY.**

**Plant Diseases.** F. T. Brooks, *Oxford University Press.* p. 286. 22*s.* 6*d.*

**Pests and Diseases of Queensland Fruits and Vegetables.** R. Veitch and J. H. Simmonds. pp. 198, illus. 64. *Department of Agriculture and Stock.*

* * *

We wish to acknowledge, with thanks, the gift of twenty Year Books and twenty-five Publications, presented by the Carnegie Institution of Washington.

## SUGAR NOTES.

*Compiled by the College Department of Sugar Technology.*

**Analysis of cane sugars.**

Particulars are given in a paper by P. Honig (*Archief* 1928, 36, II, No. 28) of the latest methods used by the Java Sugar Experiment Station for the analysis of sugars, and these are worth noting by chemists. Polarization, ash, and water content are determined in the usual manner described in most of the books, but reducing sugars have a new procedure. This is to take 33 grms. of the plantation white, 16.5 grms. of the raw, or 8.25 grms. of the molasses sugar, and dissolve these amounts in about 125 c.c. of water in a 150 c.c. calibrated flask, treating this liquid with ½, 1, or 1½ c.c. of neutral lead acetate, making up to the mark, shaking and filtering. Of the filtrate 100 c.c. are placed in a 100 to 110 c.c. flask, and treated with 1½, 3 and 4½ c.c. respectively of a 10 per cent. solution of sodium phosphate, this liquid being made up to the 110 c.c. mark, mixed, and filtered. Then the reducing sugars in it are determined by Schoorl's method (1). As for the pH value of the sugar, this is found by dissolving up 20 grms. of the sample in 30 c.c. of neutral distilled water, 10 c.c. of this solution being treated with 10 drops of the appropriate H.I.C. indicator, and compared with a standard buffer solution. Size of grain is determined by a series of Tyler standard sieves, using 50 grms., and weighing the different fractions so as to express their percentage amount (2). Colour estimation demands the use of the König-Martens spectrophotometer after carefully filtering the solution and adjusting its reaction to 7.0 pH, measurements being made at the following wave-lengths: violet 435, blue-green 509, green 546, yellow 578, orange-yellow 607 and red 725.—(*International Sugar Journal*, Vol. XXXI, No. 365.)

* * *

**Vallez Filter.**

C. Sylmans in his paper above on the results of tests obtained with Sweetland and Kroog filters, (3) also gave some particulars of the operation of the Vallez filter in the Poerwodadie s.f., Java. The total filtering surface was 50 sq. metres; the pressure 1.5 to 2.8 atmos.; time of filtration, 45 min.; and the total filtrate per sq. metre of filtering surface 4.3 to 4.9 hectolitres. Of the three types of filter, the Vallez is regarded as having given the best results generally.—(*International Sugar Journal*, Vol. XXXI, No. 365.)

(1) See *International Sugar Journal*, 1919, 578, 621.

(2) In the sieves mentioned these openings are: above 1.65 mm. (separating the lumps); 1.65 to 1.17 (coarse crystals B); 1.17 to 0.85 (coarse crystals A); 0.85 to 0.59 (crystals); 0.59 to 0.30 (fine crystals); and less than 0.3 mm. (dust).

(3) *Archief. Mededeelingen*, 1929, No. 2, 11-55.

**Constant Temperature Valve.**

A valve has recently been put on the market which is claimed to be the only automatic temperature regulator, suitable for any service, capable of maintaining a constant temperature within 1°F. The automatic control of the steam supply is operated electrically, the apparatus consisting of three principal parts, the valve itself, a thermometer, and a transformer. These may be fixed in any suitable location, connected by wires any distance apart. This apparatus has already found use in jam factories, breweries, dyeworks, chemical factories, and other manufactories extensively.—(*Int. Sug. Jnl.*, Vol. XXXI, No. 365.)

* * *

**Experiments with Kroog and Sweetland Filters.**

C. Sylmans in *Archief. Mededeelingen*, 1929, No. 2, 11-55, describes tests which were made to obtain an indication of the value of the Sweetland filter, as compared with the Kroog plate-and-frame press, as is found in many factories in Java to-day. The Sweetland used was type No. 12, having 48 leaves of a total filtering area of 64.6 sq. metres, while the Kroog had 38 frames, and a surface of 48 sq. m. It was one of a battery of nine in regular use in the Redjodgoeng sugar factory. A considerable number of runs were made, the results of which are tabulated in this article, filtration and washing curves being given. Advantages found for the Sweetland, as compared with the other were firstly, its greater capacity, which was nearly 27 per cent., using plunger pumps, and 15 per cent. using centrifugals, while other favourable points are as follows: (*a*) Cloth economy, due first to the less filtering area required, and second to fewer breakages; (*b*) saving in labour, though not to an extent important in Java; (*c*) light work, a point which on the other hand appears of some consideration in that country; (*d*) less space; and (*e*) the possibility of increasing the capacity of a battery by shortening the period of discharging. But against these points is to be placed the greater initial cost of the American apparatus. A battery of five Sweetlands of 64.6 sq.m. would cost about 80,000 Dutch florins, exclusive of pumps, and *c.i.f.* Java; whereas eight Kroogs of 48 sq.m. would cost about 32,000, that is 4,000 each, not counting pumps, and also *c.i.f.* Another disadvantage noted was the greater amount of sweetening-off water required. Sweetlands were operating in the Goenoengsarie factory, and under the conditions obtaining there, they appeared to be a complete success, eight filters of 64.6 sq.m. dealing with the entire milling capacity of 18,500 quintals or 1,850 metric tons of cane in 24 hours, and removing 9.53 per cent. of filter-scum per 100 of cane. This means 167 kg. of dry cake per sq.m. in 24 hours, and only six coolies were required for this battery of filters.—(*Int. Sug. Jnl.*, Vol. XXXI, No. 365.)

## CHEMICAL NOTES.

*Compiled by the College Department of Chemistry and Soil Science.*

**Banana Vinegar.**

In the February number of *Indus. and Engineering Chem.*, 21. 2, pp. 175-176, Dr. H. von Loesecke, of the United Fruit Company, describes how vinegar may be made from bananas. In U.S.A. vinegar is mostly prepared from apple cider, but other fruit juices may also be employed, for example, the juice of oranges, peaches and watermelons. In manufacturing vinegar from bananas, the ripe pulp and peel are made into a mash, and then pasteurized at 75°C. for 45 minutes in order to destroy acetic acid bacteria which would lead to a too rapid acetification instead of the desirable alcoholic fermentation. The cooled mash is next inoculated with a pure yeast culture, and kept at 22°C. for three days. Vigorous alcoholic fermentation is thus established. The fermenting mass is then added as a "starter" to a larger batch of mash. The fermented material is filtered, and the milky liquid centrifuged to eliminate yeast. It contains about 9 per cent. of alcohol, and weighs about 56 per cent. of the weight of fruit taken.

The banana cider is acetified by running it slowly over coke, beechwood-shavings or pumice, so as to expose as large a surface as possible to the oxidizing effect of the air. It is previously inoculated with about one-third of its bulk of finished vinegar, which contains acetic acid organisms (*Mycoderma vini*, and *M. aceti*). The product is filtered and finally pasteurized at 60°C. for one minute. The vinegar has a full yellow colour and an agreeable odour and taste.

* * *

**Component Glycerides of Cacao Butter.**

The molecular proportions of the component acids of cacao butter are not widely variable, and this fact, coupled with the phenomenon of even distribution of fatty acids amongst the glycerides of a seed fat, is probably the cause of the fat possessing its peculiarly useful technical qualities. Further, the greater part of the mono-oleo-glycerides consists of oleo-palmito-stearin, and this class of glyceride is probably mainly responsible for the characteristic texture and related properties of the fat. Oxidation of the fat by potassium permanganate in acetone shows the presence of only 2.5 per cent. of fully saturated glycerides, probably mixed palmito-stearic compounds. The content of mono-oleo-di-saturated glycerides lies between 73 and 85 per cent., and that of di-oleo-mono-saturated glycerides cannot exceed 24.5, or that of triolein 12.5 per cent. The molecular ratio of saturated acids linked with unsaturated in the mixed glycerides is 1.4 : 1, the same as in coconut and palm-kernel oils, and these results are supported by a study of the mono-azelao-glycerides in the oxidation products. Probably di-oleo-stearin is present, and in greater amounts than di-oleo-palmitin in the dioleo-glycerides. The amount of triolein can hardly exceed 4 per cent. The following general estimate of the composition of cacao butter is suggested: Fully-saturated glycerides (mixed palmito-stearins), 2.5; mono-oleo-di-saturated glycerides, 77; dio-leo-mono-saturated glycerides, 16; tri-olein, 4 per cent.—(*J. Soc. Chem. Ind.*, 1929, 48, 41-46 T.—From *The Analyst*, Apr., 1929, p. 242.)

* * *

**New Materials for Artificial Silk Manufacture.**

Under this title, an Editorial in the British journal, *The Industrial Chemist* (April, 1929), mentions sugar-cane megass, Tasmanian stringy-bark (*Eucalyptus obliqua* fibre) and New Zealand flax (*Phormium tenax* fibre). The suitability of cane-megass as raw material for the manufacture of artificial silk is fully discussed in Vol. VI, No. 7 of *Tropical Agriculture*. It is stated that the yield of dry pulp from megass is some 24 per cent. of the weight of megass taken, whereas the yield of dry pulp from spruce-wood is between 40 and 50 per cent. Spruce-wood pulp costs about £23 in Great Britain; New Zealand flax, about £19. No figures are given for sugar-cane megass nor for Tasmanian stringy-bark. Whilst there is no doubt that each of the materials is suitable for the manufacture of artificial silk, the relatively low yields of pulp which they give in comparison with spruce-wood, as well as their relatively high cost, renders them at present somewhat doubtful as sources of commercial artificial silk.

In the United States, trials are being made of flax straw as a possible material for artificial silk manufacture. Suitable pulp has been prepared from it in the United States Forest Products Laboratory, but no mention of its commercial possibilities is made.

The following table compares the contents of the different types of cellulose and certain analytical data for these various raw materials. For successful employment, a pulp must contain at least 85 per cent. of α-cellulose.

| | Sugar-cane megass pulp. | Tasmanian stringy-bark pulp. | New Zealand flax pulp. | Linen flax pulp (U.S.A.) |
|---|---|---|---|---|
| α-cellulose (per cent.) | 86.1 | 88.7 | 89.8 | 81.5 |
| β-cellulose (per cent.) | 12.6 | — | 7.0 | — |
| Copper number .. | 0.56 | 2.04 | 0.82 | — |
| Acetone extract (per cent.) | 0.26 | 0.49 | 0.12 | — |
| Yield of dry pulp (per cent.) | 24.0 | — | 64.5 | — |

## AGRICULTURE IN NORTH AFRICA.

*Jardin d'Essai, Algiers.*

卐 卐 卐

## IMPERIAL COLLEGE HOCKEY CLUB, 1928-1929.

*Photo by* *H. O. Thomas*

*Standing :* H. L. Manning, C. A. Thorold, A. N. Prentice, R. G. H. Wilshaw, L. P. McGuire, C. G. Akhurst.

*Sitting :* H. H. Croucher, R. Leach, A. C. Maher (*Capt.*), B. J. Hartley, A. S. Thomas.

**IMPERIAL COLLEGE TENNIS CLUB, 1928-1929.**

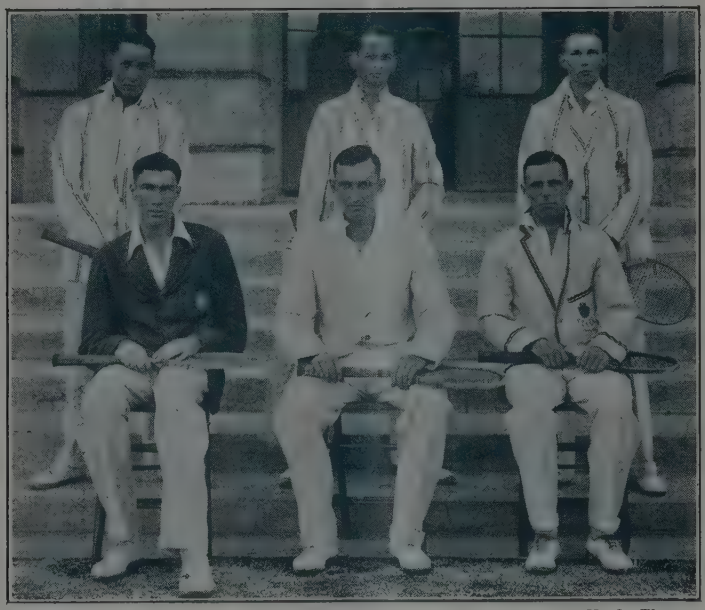


*Photo by* *H. O. Thomas*

*Standing :* R. M. D. Barnard, J. A. McDonald, A. Sheffield.
*Sitting :* L. S. Birkett, B. J Hartley (*Capt.*), H. H. Croucher.

**IMPERIAL COLLEGE CRICKET CLUB, 1928-29.**

*Photo by* *H. O. Thomas.*

*Standing :* J. Wright, A. L. Grogan, Capt. J. M. Wingate, A. F. Nichols, A. N. Prentice.
*Sitting :* R. G. H. Wilshaw, L. S. Birkett, R. Leach (*Capt.*), C. A. Hynam, C. G. Akhurst.

## SPORTS.

### Hockey Retrospect, 1928-1929.

THE past season has been quite successful and very enjoyable. Many an enthusiast was heard to declare that 'Hockey is *the* game for the tropics.'

This year, for the first time, a hockey pitch was maintained, part of the cricket ground being utilised for this purpose, and many practice games and matches took place on this pitch which, for its first season, "played" very well. The possession of this ground enabled a 2nd XI to be established, in which many men were initiated into the game, and which served as a training school for several very efficient reserves for the 1st XI.

Among matches played on this ground were the following:

| | | | |
|---|---|---|---|
| 6th February | *v* | *H. M. S. Durban* | Lost 0-1 |
| 5th March | *v* | Constabulary | Won 3-2 |
| 10th March | *v* | Trinidad Leaseholds | Won 6-3 |
| 23rd April | *v* | Major Carr's XI | Won 4-2 |

Many additional games were played, especially preparatory to the commencement of the League fixtures, principally with the Constabulary and the Wanderers Clubs.

The team was unfortunate in losing the services of two of its best players; A. K. Briant, through injury at the very beginning of the season, and F. R. Sanders, who was forced to retire from active participation, half-way through the season, owing to an importunate appendix.

The great strength of the team lay in the defence which was rarely other than sound, occasionally being really brilliant, and gave strong support to the forwards. Many players were tried out in the forward line, but as a cohesive unit of attack this never showed great scoring ability though quite adequate till the circle was reached. However, the forwards were gradually sifted down to a fairly constant personnel, and individual members of the line would often have an "on" day sufficient to bring home the points to St. Augustine. The final position attained in the Trinidad Hockey Association League table was third.

Results were as follows:

| | | | |
|---|---|---|---|
| 21st December | *v* | Constabulary | Lost 1-4 |
| 3rd January | *v* | Sporting Club | Won 3-1 |
| 9th January | *v* | Rugby Club | Won 6-2 |
| 14th January | *v* | Casuals | Won 5-1 |
| 18th January | *v* | Wanderers | Lost 0-3 |
| 25th January | *v* | Rovers | Lost 1-2 |
| 22nd February | *v* | Sporting Club | Won 5-0 |
| 4th March | *v* | Casuals | Won 4-0 |
| 8th March | *v* | Constabulary | Lost 1-5 |
| 15th March | *v* | Rugby Club | Won 1-0 |
| 21st March | *v* | Wanderers | Lost 0-1 |
| 16th April | *v* | Rovers | Won 4-2 |

### The Geddes Grant Cup.

The League being concluded, interest centred in the Geddes Grant Cup competition. Having disposed of the Leaseholds (18th March, Won 2-0) and the Wanderers (27th March, Won 2-1) in the two first rounds, after excellent and hard-fought games, the College was matched against the Trinidad Northern Rugby Club in the Final. More than usual excitement attended this event in view of the fact that this was the third successive year in which the College had figured in the final of this competition.

The Rugby Club were met on 5th June and, though the College had by far the better of the game, a goal-less draw resulted, an issue not entirely unsatisfactory, as the sudden illness and retirement of W. Bushe from the Rubgy Club side just after the interval had cast a shadow over the rest of the game.

The replay took place on 7th June when, with a reorganised team, the Imperial College displayed great superiority, and the forwards showing far better combination, defeated the Rubgy Club by two goals to nil.

This ended the season in a very happy manner, and the Hockey Club had the satisfaction of being the first of the College teams to bring back a sports Cup to the Imperial College.

The team which represented the College in the Final Replay of the Hockey Association competition for the Geddes Grant Challenge Cup was as follows:

*Goal.*
H. L. Manning.
*Full Backs.*
B. J. Hartley; R. Leach.
*Half Backs.*
W. B. Hutchinson; A. C. Maher; C. G. Akhurst.
*Forwards.*
A. N. Prentice; R. G. H. Wilshaw; C. A. de Silva; A. S. Thomas; C. A. Thorold.

The following have also played for the College: H. H. Croucher; L. P. McGuire and F. R. Sanders.

A. C. M.

* * *

### Tennis Retrospect, 1928-1929.

The club was fortunate in having several of last year's team still in residence, and no trouble was experienced in getting together a VI. As far as results were concerned the season was not a success, it should be remembered however that a high standard of tennis is played in the Island.

Eight matches were played, three being won and five lost. The College was beaten on three occasions by Tranquillity Club, very narrowly by Trinidad Leaseholds and once by Sub-Inspector Franklins' VI.

A Singles Handicap Tournament was held, the finalists as was anticipated, being Birkett owe 30 and McDonald owe 30, the latter winning 6-3, 6-4. McDonald was presented with a miniature of the Singles Handicap Cup which is to be played for annually.

The following have represented the College on different occasions: L. S. Birkett, B. J. Hartley (*Captain*), A. Sheffield, A. N. Prentice, A. E. Trotman, J. A. McDonald, H. H. Croucher, R. M. D. Barnard, R. G. H. Wilshaw and C. Maher.

B. J. H.

### Cricket Retrospect, 1928-1929.

The season can be considered to have been very successful from the point of view of the match results. The enthusiasm of all concerned and the sequence of so many exciting finishes also made it an exceedingly enjoyable one.

Of the nine matches played, six were won, two drawn and one lost. The following is a list of the results:

| | | | |
|---|---|---|---|
| 2nd Feb. | College 151 | *H.M.S. Durban* 129 | Won by 22 runs |
| 17th Feb. | Leaseholds Ltd. (Pointe-a-Pierre) C. C. 115 | College 218 for 3 | Won by 7 wkts. & 103 runs. |
| 24th Feb. | Mr. W. F. Bushe's XI 76 | College 104 for 6 | Won by 4 wkts. & 28 runs. |
| 3rd March | Sub-Inspector J. W. Franklin's XI 153 | College 129 for 7 | Drawn |
| 7th March | College 203 for 2 | *H. M. S. Colombo* 133 | Won by 70 runs |
| 21st April | College 137 | Mr. W. F. Bushe's XI 128 | Won by 9 runs |
| 28th April | College 74 | Leaseholds Ltd. (Pointe-a-Pierre) C. C. 73 | Won by 1 run |
| 5th May | Major Harragins XI 180 | College 145 for 8 | Drawn |
| 12th May (away) | College 108 | Queen's Park C. C. 118 for 8 wkts. | Lost by 2 wkts. & 10 runs. |

Batting Averages.

| *Name.* | *Inns.* | *Total.* | *N.O* | *H.S.* | *Average.* |
|---|---|---|---|---|---|
| L. S. Birkett .. | 7 | 306 | 2 | 146* | 61.2 |
| R. Leach .. | 7 | 262 | 0 | 86 | 37.4 |
| R. G. H. Wilshaw | 5 | 112 | 2 | 44* | 37.3 |
| J. M. Wingate .. | 6 | 73 | 2 | 29 | 18.3 |
| F. R. Sanders .. | 5 | 79 | 0 | 29 | 15.8 |
| J. Wright .. | 5 | 56 | 0 | 15 | 11.2 |

Bowling Averages.

| *Name.* | *O.* | *M.* | *R.* | *W.* | *Average.* |
|---|---|---|---|---|---|
| R. Leach .. | 104 | 22 | 287 | 40 | 7.2 |
| L. S. Birkett .. | 72 | 19 | 159 | 13 | 12.2 |
| J. M. Wingate .. | 34 | 4 | 116 | 8 | 14.5 |
| A. F. Nichols .. | 40 | 2 | 183 | 10 | 18.3 |
| C. G. Akhurst .. | 52 | 6 | 169 | 8 | 21.1 |

The following played for the College: R. Leach (*Captain*); L. S. Birkett, C. A. Hynam, R. G. H. Wilshaw, C. G. Akhurst, F. R. Sanders, Capt. J. M. Wingate, A. F. Nichols, A. L. Grogan, A. N. Prentice, J. Wright, A. F. W. Sheffield, C. A. de Silva, C. W. Lynn and A. C. G. Palmer.

* Not out.

R. L.

## GIFT TO SUGAR FACTORY.

The College is very greatly indebted to Messrs. McNeil & Co., Ltd., of the Colonial Iron Works, Glasgow, for presenting them with a combined sugar mill and gearing. The mill has rollers 10 inches in diameter by 14 inches long, grooved on the surface, the headstocks being made of cast steel and carrying gunmetal bearings for the mild steel shafts. The mill which has been supplied complete with gearing for driving by an electric motor will be used in the sugar technology laboratory for experimental purposes.

## COLLEGE NEWS.

Mr. A. G. Howell and Mrs. Howell sailed for Barbados by s.s. *Bayano* on 26th July.

* * *

Mr. G. A. Jones, Assistant Commissioner of Agriculture for the West Indies, and Mrs. Jones, sailed for St. Kitts and the Northern Islands by s.s. *Lady Drake* on 17th July.

* * *

Mr. G. G. Gianetti, Editor-Librarian, sailed for Barbados by s.s. *Venezuela* on 23rd July, returning by s.s. *Ariguani* on 27th July. During his stay he paid two visits to the Department of Science and Agriculture.

* * *

Dr. C. W. Wardlaw, Pathologist to the College Banana Research Station, and Mrs. Wardlaw returned from St. Lucia by s. s. *Lady Nelson* on 25th July. Dr. Wardlaw sailed for Surinam and British Guiana by s.s. *Nickerie* on 11th August.

* * *

Dr. H. R. Briton-Jones, Professor of Mycology and Bacteriology, who will represent the Leeward and Windward Islands, Barbados and the College at the Imperial Mycological Conference to be held in London from 28th September to 5th October, sailed for England by s.s. *Camito* on 9th August.

* * *

The following recently visited the College: Mr. F. Balfour-Browne, Professor of Entomology, Imperial College, London; Rev. J. Firth and a party of Boy Scouts from British Guiana bound for the Jamboree; Messrs. E. M. Nicholson, B. D. Nicholson, N. Y. Sandwith, O. W. Richards, F. E. Buckland, J. E. Duffield, L. Slater, M. J. Creswell, S. T. A. Livingston-Learmonth and P. W. Richards of the Oxford Expedition to British Guiana.

## COLLEGE AMALGAMATED CLUBS.

A Meeting of the Imperial College Amalgamated Sports Clubs was held on 13th June, in the presence of nearly all the students and members of the staff. The Principal, during the course of his address, said that the year had been one of the most successful from the point of view of sport and congratulated the captains and teams on their respective performances. He was particularly pleased with the Hockey team who were the first team in the history of the College, to win a cup, and with the Rugby XV who had not lost a match. With regard to Tennis, he congratulated Mr. McDonald on winning the Singles Handicap Cup and regretted the fact that the miniature cup had not arrived in time to be presented to him on that day. After dwelling for some time on the value of games in the tropics, he thanked Captain Wingate warmly for all the hard work which he had put in during the year as Chairman of the Amalgamated Clubs. His tact and the able way in which he had shouldered his responsibilities had been greatly appreciated, and had earned him the respect of all his colleagues.

Turning to the theme of work, the Principal expressed the hope that the aims of the staff to make the students familiar with tropical conditions and tropical matters, had been realised. He stressed the value of agricultural and biological excursions. The latter had only been recently inaugurated and had proved a great success. In bidding the students farewell and wishing them good luck in their future careers he hoped that they would write and give their impressions of their work and surroundings. It was only in this manner that it would be possible to collect information which might eventually prove of much value in framing any changes in the present College curriculum.

Captain Wingate replied by thanking the Principal and staff for what had been done for the students, and Professor Briton-Jones for his ready help in all matters connected with the Clubs. The year had indeed been a very successful one, the games had been well supported and he could never have had a better lot of fellows to deal with.

## VISIT OF OXFORD EXPLORERS.

MAJOR R. W. HINGSTON, M.C., and all the members of the British Guiana Expedition of Oxford Scientists visited the College on 3rd August. The party after being met on board the s.s. *Ingoma* by Mr. R. O. Williams, Superintendent and Assistant Botanist of the Royal Botanic Gardens, Trinidad; and in Port-of-Spain by the Acting Principal and other members of the Staff, proceeded to the College in cars by way of the Saddle Road. The morning was devoted to an inspection of the College main buildings, the new Biochemical Laboratory, the cold storage plant and the Sugar Factory; and the afternoon, to a visit to the Cotton Station under the escort of Mr. Hutchinson, and to the College farm and Professor Cheesman's experimental plots. The party lunched and had tea at the Milner Hostel and also bathed in the College swimming pool. They showed great interest in all that they saw and the more enthusiastic members collected various botanical and entomological specimens. Mr. Urich also took the entomologists for a drive to Maracas Valley, but on finding the road impassable at a certain point on account of floods, this party had to proceed to Caura Valley where their entomological pursuits appear to have been successful as they returned to the Lighthouse Jetty in Port-of-Spain laden with spoils. Mr. Williams also took one of the botanists to the Gardens where Herbarium specimens were examined. The whole party re-embarked before sundown after a day which was fortunately favoured by excellent weather.

The Editor requests that any subscriber who fails to receive *Tropical Agriculture* regularly should communicate with him immediately in order that the matter may be rectified.

## MYCOLOGICAL CONFERENCE.

THE Second Imperial Mycological Conference will be held in London from 28th September to 5th October. Amongst the subjects to be discussed will be the work and organization of the Bureau; the formulation of a standard method of handling dangerous material (specimens and cultures) in mycological laboratories; root diseases of orchard and permanent plantation crops; the existing organization of plant pathological (plant protection) services in various parts of the Empire; virus and seed borne diseases; soil borne and soil induced diseases; the organization of spray services based on weather forecasts; diseases developed in fruit shipped overseas; methods of obtaining standardized proprietary disinfectants with special reference to (*a*) coal tar derivatives, (*b*) mercuric compounds; Witches' broom disease of cacao; the breeding of a commercial lime immune from withertip disease and the control of insect pests by entomogenous fungi, with special reference to island conditions.

## SUGAR-CANE MEGASS.

Mr. R. E. Kelsick, Agricultural Superintendent, St. Kitts, reports that laboratory experiments in connection with the effect of additions of sugar-cane megass to the soil and the rate of nitrification of fertilisers indicated that when applications of megass are made direct to the soil no nitrates are available for the growth of the plant for a very considerable time (11 weeks so far) as a result of increased activities of soil bacteria. A plot of land which was treated with megass is now being examined to ascertain if this result is borne out in the field.

The laboratory nitrification experiments with sulphate of ammonia and fish manure show that these give maximum nitrification between the seventh and ninth weeks when applied to St. Kitts soils.—(*Bulletin of the Imperial Institute*, Vol. XXVII, No. 2)

## GIFT TO THE MYCOLOGICAL DEPARTMENT.

Our thanks are due to the Four Oaks Spraying Machine Co., Sutton Coldfield, England, for their very valuable gift of different kinds of spraying and dusting machines. The equipment presented has been very greatly appreciated, and some of the machines have already been used for experimental and demonstration purposes.

## JAMAICA BANANA EXPORT.

Excellent progress is shown by the Jamaica Banana Producers' Association in the first ten weeks of its operations. During that period 1,123,117 stems of fruit were shipped, and the Government, which had guaranteed debentures to the amount of £4,500 on the costs of the ships engaged in the banana trade, was reimbursed.—*Reuter.*

## TREND OF THE MARKETS.

[*The notes below are based principally upon running charts of the prices of the basic grades and upon general statistical information gleaned from contemporary publications and cablegrams and are intended to be a record of movements. An attempt is made, where possible, to indicate the market outlook at the time of going to press, but no responsibility for the accuracy and subsequent truth of such observations is assumed. Unless otherwise stated the prices quoted are spot, London.*]

Sugar.—Prices on the Home Markets have ranged as follows (*c.i.f.* per cwt.):

| | *Foreign.* | *Preferential.* |
|---|---|---|
| | *s. d.* | *s. d.* |
| 4th July .. .. | 9 1½ | 12 10½ |
| 13th July .. .. | 9 6 | 13 3 |
| 20th July .. .. | 10 0 | 13 7½ |
| 25th July .. .. | 9 9 | 13 6 |
| 29th July .. .. | 9 3 | 13 0 |
| 31st July .. .. | 9 0 | 12 9 |
| 9th August .. | 8 9 | 12 9 |
| 16th August .. | 8 9 | 12 6 |

Continued firmness characterised markets during the first four weeks in July. The improved position of the article has been due to various outside influences of which the most important are the Brussels Conferences aiming at some restriction of world crops (notably Cuba and Java), the uncertainty prevailing in America on the Tariff question and the question of a single seller in Cuba for the balance of the present crop. Some disquietude has been caused by the Chancellor of the Exchequer's hint that sugar duties and preference may be abolished in England. The West Indies Associated Chambers of Commerce have protested against this. Towards the end of the month a more subdued tone prevailed but under the influence of political developments it is not unnatural that the market should find itself in a somewhat hesitant mood.

* * *

Cotton.—The following are the official spot prices in pence per lb. of the Liverpool Cotton Association:

| | *American Mid.* | *Egyptian F. G. F. Sakel.* | *Sea Island.* | | |
|---|---|---|---|---|---|
| | | | *Good.* | *Extra fine.* | *Prices paid this Week.* |
| 7th June .... | 10.27 | 17.00 | 25.50 | 38.00 | 25.50-30.00 |
| 28th June .... | 10.33 | 16.20 | 20.50 | 38.00 | 26.75-27.00 |
| 5th July .... | 10.28 | 16.30 | 25.50 | 38.00 | — |
| 12th July .... | 10.21 | 16.30 | 25.50 | 38.00 | 24.00-27.50 |
| 19th July .... | 10.54 | 17.00 | 25.50 | 38.00 | 25.50-30.00 |
| 16th August (local) | 10.10 | — | 25.50 | 38.00 | — |

Sea Island has been in limited demand without change in quotations. According to the *Commercial* for 25th July the sudden recovery of American-mid was due largely to technical re-adjustment, following a decidedly oversold condition though the rapidity of the movement and its extent were helped materially by fears that dry weather in West Texas and continued showery conditions in the Valley and Eastern States would bring about more than normal deterioration.

* * *

Cocoa.—The market continues quietly steady. Manufacturers are not showing much interest but generally demand from this source slackens in the summer months.—(*By courtesy of the Cocoa Planters' Association, Trinidad.*)

* * *

Coffee.—Fairly large supplies, mostly Costa Rica have been brought to Auction in the past month. Many of the Foreign-cleaned parcels were unattractive and did not conform to home-trade requirements, but good London-cleaned attracted attention. Kenya of poor quality sold at unchanged prices. Small supplies of Blue Mountain Jamaica met competition, and sold at 186*s.* to 200*s.* for fine rather dull; 213*s.* to 236*s.* 6*d.* for fine bright colory.—(Gillespie Bros. & Co., Ltd., *Monthly Review*, 24th July.)

* * *

Tea.—On 13th July, London tea stocks were 22,795,000 lb. higher than a year ago, but the demand is so good and so well sustained that these accumulations are steadily being worked off. Indian has averaged 14.54*d.*, Ceylon 17.00*d.*, Java 11.31*d.*, and Sumatra 14.03*d.* per lb.—(*Times Trade and Engineering Supplement*, 29th July.)

* * *

Rubber.—Quotations for Plantation Sheet have ranged as follows: 13th July, 11⅛*d.*, 19th July, 10⅞*d.*, 24th July, 11*d.*, 31st July, 11 1/16*d.*, 10th August, 10⅞*d.*, 16th August, 10¼*d.* Fluctuations have been small and the tone of the market somewhat dull with a slightly declining tendency.

* * *

Copra.—Prices have tended upwards, the peak being touched on 18th July when £24 15*s.* 0*d.* *c.i.f.* was made for West India. A recovery of £4 per ton in about a month. A reaction then set in and prices dropped to £23 15*s.* 0*d.* *c.i.f.* London. (25th July.)

* * *

Bananas.—Bananas continue in very good demand. Jamaicas are quoted unchanged at £23 per ton to wholesalers (*delivered*), and 1*s.* per dozen to retailers (carriage extra), Brazilians are quoted at £22 10*s.* per ton delivered London, and £22 per ton delivered nearest railway station in Provinces.—(*West India Committee Circular*, 25th July.)